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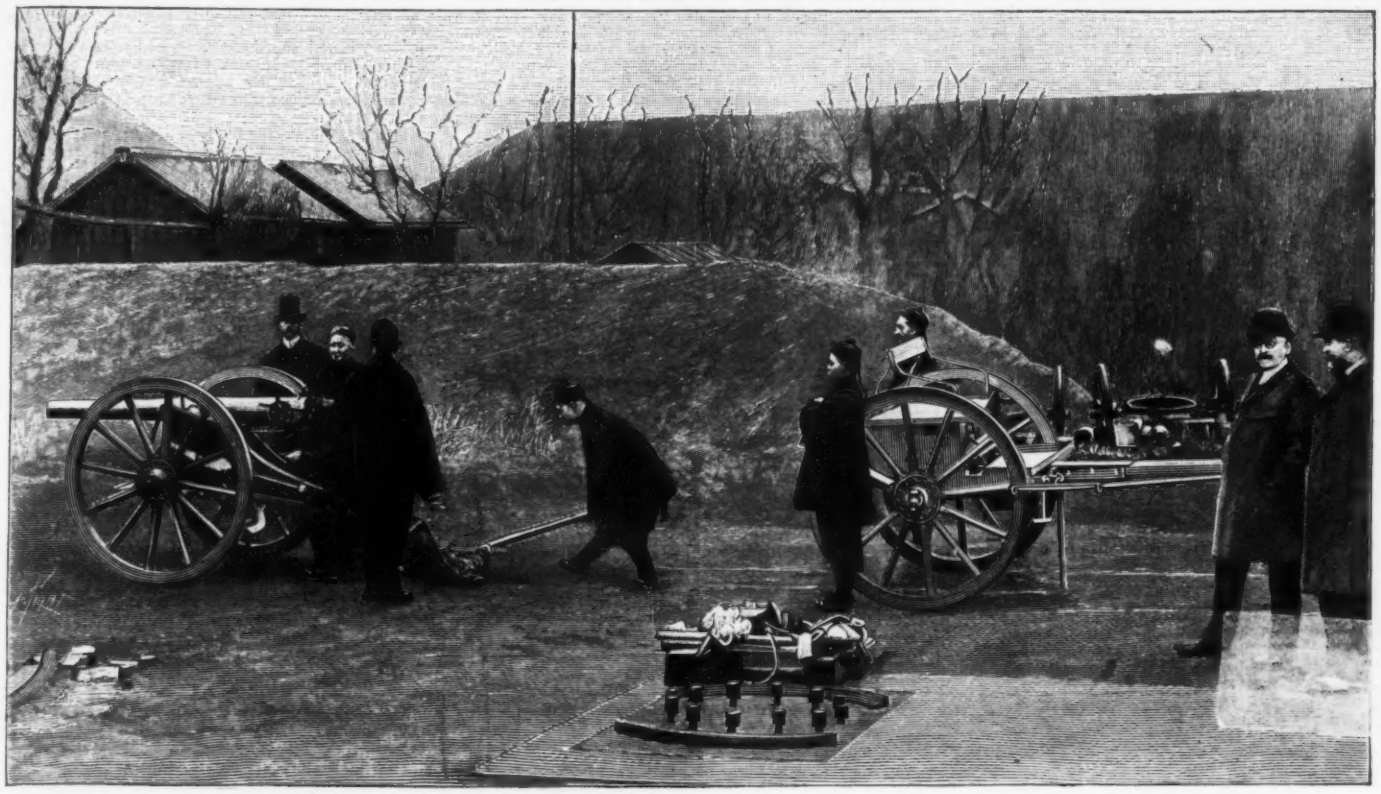


GUN EXERCISE BY CHINESE ARTILLERY PUPILS, UPON THE ESSEN PROVING GROUNDS, IN PRESENCE OF FRIEDRICH KRUPP.

CHINESE ARTILLERY PUPILS SERVING A HEAVY GUN FOR COAST DEFENSE.

THE KRUPP WORKS.

AMONG all the industrial cities of the basin of the Ruhr, that of Essen is at present the most universally known, owing to the metallurgic establishments of Friedrich Krupp, the last male heir of the recent dynasty of the "gun kings."

The Krupp establishments now form the greatest works in the world. They comprise the forges of Essen, and those of Annen in Westphalia, the celebrated Gruson plant at Buckau, near Magdeburg, four blast furnace annexes, four coal mines, five hundred shafts for the extraction of iron, iron mines at Bilbao, Spain, proving grounds at Meppen, three steamships, various quarries, etc. Moreover, the Krupp establishment directs the exploitation of the "Germania Society" of Berlin and Kiel for the building of ships and engines.

The works occupy at Essen an area of over 1¼ square miles, 152 acres of which are built upon. In 1899 they used 3,913,796,815 gallons of water, a quantity almost exactly equal to that consumed by the city of Frankfort; and 665,195,105 cubic feet of gas for the manufacture of steel and for lighting. Between 1898 and 1899, the forges daily worked 1,847 tons of iron taken from the mines owned by the establishment. During the year 1899 the Essen works used 936,317 tons of coal and coke, and the other works and the steamships consumed 612,288 tons. Altogether, the Krupp establishments use annually, therefore, 1,549,606 tons of fuel, or about 5,000 tons a day. On the first of April, 1900, the number of men employed by Friedrich Krupp was 46,679.

The Krupp works do not limit their activity to the manufacture of guns, ammunition and accessories, but produce also what a pamphlet, published at Essen, calls "peace material"—that is to say, car wheels, rails, parts of locomotives, and steel castings for steamships, engines, etc.

At the end of 1899 the steel works of Essen had manufactured and sold 38,478 guns. Friedrich Krupp, the present owner of these gigantic works, belongs to a very old family of the city, which was interested in small metallurgic exploitations as far back as the eighteenth century. At the epoch of the continental blockade, Friedrich Krupp, the grandfather, discovered the method of making cast steel, but lost his entire fortune in the enterprise, and it was left to his son Alfred to give a decisive boom to the business. Alfred Krupp was fourteen years of age at the death of his father, on the occurrence of which he immediately left college in order to put himself at the head of the modest industry, which then employed but two workmen. Before his death, the father had confided to his son his process for producing cast steel. Six years afterward Alfred had ten workmen in his employ. He was a man of great patience and passionately fond of his calling, and while gradually building up his business, never ceased to dream of making improvements in metallurgy. The starting-point of his great fortune was the invention of a machine for the manufacture of spoons. In 1847 he sent to the Prussian Minister of War a steel gun, the idea of which he had long before conceived. This experiment, at first without any result, was, in the future, to have the greatest consequences, since it was destined to destroy the ancient bronze artillery and gradually to permit of the construction of the formidable instruments necessary for modern warfare.

In the middle of the nineteenth century began the true reign of iron, through the establishment of railways. At the London Exhibition in 1851, when the attention of the entire world was directed to the manufacture of steel in mass, the English made a great noise about a 20-ton block, which they considered something wonderful; but Alfred Krupp astounded everybody by producing a piece that weighed 45 tons. Five years afterward, Krupp was employing a thousand workmen, and his prosperity was more and more marked by a series of inventions and the construction of huge power hammers. At every great exposition he gained a ringing success, and his guns finally attracted the attention of artillerists, who were, however, at first prejudiced and unyielding. In 1855, at the Paris International Exposition, he showed a 100-ton block of steel and a 12-pound gun. This latter excited much curiosity, and Emperor Napoleon, who was much interested, sent for the inventor, organized a commission and assisted, himself, at the tests of the famous gun. It is asserted in the Krupp works that Napoleon III. was fully convinced by the experiments, and offered to purchase three hundred of these pieces of artillery, but the inventor refused to sell, through patriotic scruples. Such patriotism, however, seems to have been an afterthought. In 1855 the Prussians were not as yet using the steel gun, and, like the French artillerists, even undervalued it, and did not adopt it until much later. Let us note that such categorical rejection did not prevent the Essen manufacturer from making an exhibit, in 1867, at Paris, where, in a marble hall, he installed a huge gun that weighed 111,000 pounds, and the value of which was $108,000. This exhibit gained the grand prize for the works, and three years later their owner was decorated by the hands of the Empress Eugenie herself.

In 1870 the sinister renown of the Essen works was definitely fixed, and yet the few first years that followed the war were most precarious. The steel works were able to save themselves from a catastrophe only through a loan made by Berlin bankers who were inspired by patriotism. At present they are on the high tide of prosperity and are participating in the great business movement of Germany. At present there exist in the United States, England and France gun manufactories that are capable of producing ordnance that is comparable with, and even superior to, that of Krupp, but the latter has acquired a celebrity that will for a long time be indestructible, and that is even increasing in consequence of a perfect commercial organization.

The Essen works begin in a long street bordered by large walls. Here and there huge water or gas mains are fixed across the streets above the heads of pedestrians, and to the right and left tall chimneys emit clouds of smoke. It is not our intention to describe here the steel works and the various processes of manufacture, but rather to pass in review a few of the peculiarities of the Krupp establishments.

One of the principal elements of the commercial wealth of the gun works is the polygon of Meppen, situated eleven hours' journey from Essen, near the banks of the Ems. It is said that no country possesses proving grounds so complete as these. They are provided with all the facilities and all the apparatus necessary for ascertaining the effects of the guns. The rapid means of transportation throughout the polygon and a fine telephonic system permit of judging the shots without delay. It is asserted that the old German officer who directs the operations of the grounds is so well versed in all the questions of ballistics, and is so extraordinarily skillful in quick calculation, that he perplexes foreign experts sent to Meppen, and that these latter even dare not ask questions for fear of appearing ignorant.

At the extremity of the grounds, a bridge 245 feet in length carries two formidable traveling cranes, designed for lifting guns and placing them upon their carriages. All around and beneath are seen nothing but guns.

The polygon is 55,000 feet in length, and affords facilities for shooting to a distance of 15 miles. Such great distances are necessary for the testing of guns manufactured for coast protection. It is possible for the Krupp 12-inch gun, at 40 degrees elevation, to send its projectile 15 miles.

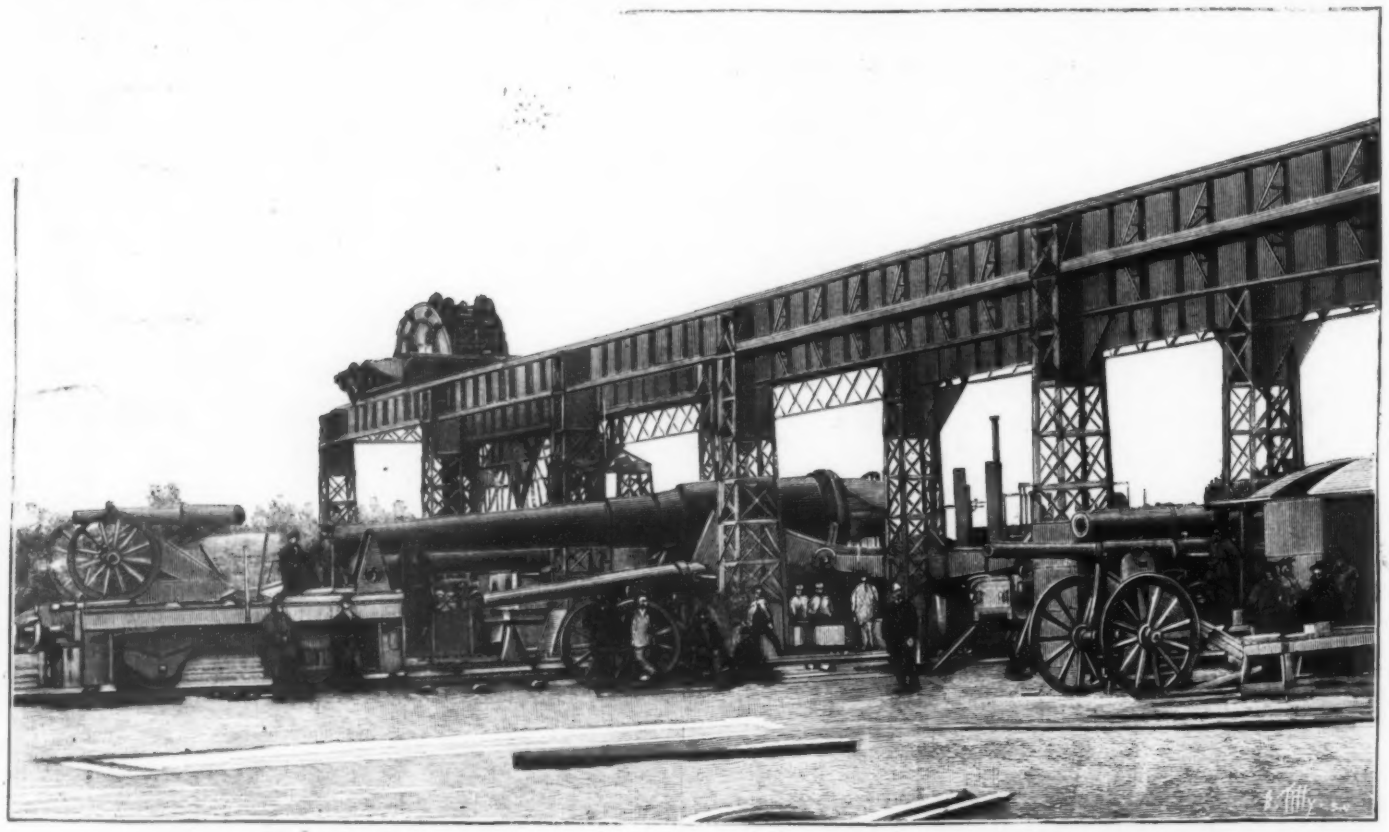
The workingmen's and benevolent institutions are perhaps more interesting than the products of the establishment. Social questions here receive much attention. So large an agglomeration of men has naturally not been able to escape the shocks that the contests with manual labor cause all industries to experience. There have been strikes at Essen, as well as threatened strikes. In 1877 Alfred Krupp conceived the idea of having old Field Marshal Von Moltke appointed on the Essen deputation to the Reichstag. In response to his propaganda the workmen gave 7,828 votes to the socialist candidate. This check caused the management of the works to reflect, and since that epoch more and more attention has been given to labor problems.

The provident associations patronized by Friedrich Krupp deserve to be studied minutely, for they are numerous and methodically organized. They show by their importance that there has been a desire to bind the workmen to the fate of the house by a thousand chains of interest. It would require many pages to describe the casinos of the head employes and foremen; the temples, the churches; the quarters for bachelors, etc.

Among the various schools, the one at which domestic economy is taught is particularly interesting. Young girls here learn to cook and keep house, and each of them in turn has to devise a bill of fare and do the marketing, and in such a manner that the entire meal shall cost no more than 9 cents a head.

The Chinese artillerists who fired so cheerfully at the Europeans were instructed at Meppen—some of them under the eyes of Friedrich Krupp, who takes good care of his customers. In fact, he has built in the city a magnificent hotel in order to entertain foreigners called to Essen by business with the works. The "Essener Hof" is installed according to the most rigorous exigencies of comfort and with a "new art" luxury that may displease certain persons, but which makes a deep impression upon the majority of visitors. Here, amid surroundings of an elegance to which most of them are unaccustomed, Krupp's guests are pampered and lodged. The table is one of the best in Germany, and the cellars contain nothing but famous vintages.

It may well be imagined that, thus looked after by the celebrated master of forges, purchasers have, almost despite themselves, a tendency to approve of the steel of a house whose cuisine is so good. The fortune of the Krupp establishment was assuredly established by the quality of its products, the excellence of its steel, the tumult of certain wars and the Meppen proving grounds; but, from what has just been said, it will be seen that the Essen works do not neglect other means to attract patronage.—For the above particulars and the engravings, we are indebted to L'Illustration.



THE PROVING GROUNDS AT MEPPEN, SHOWING GUNS AND TRAVELING CRANE.

THE BAGDAD RAILWAY.

IN the early part of August, 1900, there was an interchange of dispatches between the German Emperor and the Sultan Abdul Hamid concerning the eventual direction to be taken by the projected Bagdad Railway, and this immense undertaking has already entered on the first stages of its accomplishment, says the Engineer. A German committee of construction has inspected the various sections that have already been many times triangulated and surveyed, and the final direction to be taken by this international line of railway has been settled.

The striking importance of the projected railway, both from a political and civilizing aspect, attracted long ago the attention of the whole civilized world. Unfortunately, it has not been possible hitherto to study at all deeply the various conflicting interests, owing to the absence of a suitable review of the mass of literature dealing with the region of Asia Minor. But German thoroughness has risen to the occasion, and this want has been supplied by the publication by Herr Siegmund Schneider of a work entitled "The German Bagdad Railway and the Projected Bridging of the Bosphorus: Their Importance to International Trade and Intercourse." Herr Schneider has examined thoroughly both German and foreign literature dealing with the subject. He lives in Turkey, and is able to depict the state of affairs in the East from his own observation. It is quite impossible to deal at length with this most interesting work, and we must confine ourselves to referring to the commercial and political aspects involved in the construction of the railway.

The Bagdad Railway will be a variant of the primæval trade routes that led to the Indies. Far back in the beginnings of history the "Kings' Road" led from Susa and Sardes across almost the whole of Asia Minor. This artificial road, laid down by Persian satraps, formed for fifteen centuries the connecting link between Europe and the Indies. It was only when the civilization of this link in the intercourse between two continents came to nought, as the result of great historical catastrophes, that the commercial intercourse forsook its high roads, and the nations of the Western World then began to trade by sea with the East Indies. For three centuries the route mapped out by Vasco de Gama to the Indies was followed, until the route thither was changed for the third time when Lesseps dug the Suez Canal. Now, thirty years after the completion of that great work, a new direction bids fair to be given to international commerce by the realization of a project which has been entertained for the last seventy years. Even in 1838 Von Moltke advocated resuming the restoration of the overland route across Asia Minor to India by reviving to new life the old Persian "Kings' highroads" by the introduction of railways, and the projected Bagdad Railway will really follow the route taken by these roads of antiquity.

The opening out of Asia Minor will bring about a revolution in the markets of the world. At this moment the Anatolian railways export 250,000 tons of cereals, 100,000 tons of rock salt, and 40,000 tons of wool; in return they import 9,500 tons of iron and manufactured goods from Germany, 6,000 tons of petroleum from Russia, and 4,500 tons of Austrian sugar. Turkey's exports in breadstuffs are simply a bagatelle compared with its real and undeveloped powers of production. Of all corn-producing countries Turkey has perhaps the greatest chance of coming to the front, and thereby competing with the United States in supplying Europe. This prospect holds good also with regard to the production of Turkish cotton. In this respect Germany is especially interested, seeing that it now pays £1,500,000 yearly for imported raw cotton, and is always liable to have its supplies cut off, as was the case during the American civil war of 1861-62. These prospects have a very enticing sound, yet they can scarcely be made the basis for an undertaking which will involve an expenditure of £17,500,000, when it is remembered that the entire population of the district in question stands so greatly in need of the simplest forms of modern civilization. Herr Schneider is equally optimistic in comparing the naphtha deposits of Babylonia with those of the United States and Russia, although he knows full well that the naphtha beds in Asia Minor have neither been explored nor estimated. Even if the question arose of working the naphtha deposits with a view to procuring a supply of liquid fuel, then it may be claimed that Asia Minor, unlike Russia, does not possess the factories, railways and steamers which by their consumption of naphtha as fuel, would result in the oil fetching a very high price.

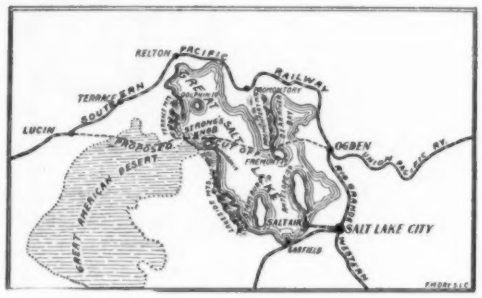
The Russian press has viewed this German project with ill-disguised alarm, for this activity on the part of Germany has forestalled the slow and sure designs of Russia with regard to Asia Minor. It is, therefore, not surprising that the Russian press should predict a rude awakening for Germany in its endeavor to "make its way inch by inch through the never-ending thick wall of indolence, slothfulness and stupidity which Turkish rule has raised in a land which formerly was so flourishing." At the same time, Russian experts admit that the Bagdad Railway will occupy an important position among the great railways of the world, if by its means a portion of the through communication with India can be included in "the Russo-Persian railway combination." This suggestion on Russa's part clearly amounts to an offer to accept the inevitable on condition that Germany will agree to place a section of this new overland route to India under Russian control. This, of course, is a roundabout way of trying to paralyze the immense advantage that must in time accrue to Great Britain so soon as the Bagdad Railway shall have shortened still more the overland journey between London and Bombay. This development of German enterprise in Asia Minor comes at a most inopportune moment for Russia. The financial condition of the latter country is not such as to permit the Imperial authorities to pursue their project of opening up Persia by a network of railways which, being connected with the Trans-Caucasus Railway, would carry Russian influence into the heart of the Shah's kingdom, and give Russia that long desired "window on the Indian Ocean." Nevertheless, a proposal was recently made in the Russian press that the Trans-Caucasus Railway should be extended from Tiflis in a southwest direction and across Armenia, with a view to "tapping" the German Bagdad Railway at Diarbekr. The chief feature of the Bagdad Railway is the fact that its construction will create a German "sphere of influence" in Asia Minor, for German settlers are bound to flock into that region in obedience to the desire expressed by the German Emperor during his tour in Palestine, that his subjects will set an example of activity to the Mohammedans, and thereby assist in awakening Asia Minor to a new life. Thus, the prosaic locomotive whistle is destined to echo through the desert places of the cradle of the human race, and to awaken the land from its sleep of centuries.

A RAILROAD THROUGH GREAT SALT LAKE.

By KENNETH C. KERR, in The Railway Age.

EARLY last summer scientific and engineering circles were deeply interested in the announcement that surveys had been ordered by the Southern Pacific for a line across the Great Salt Lake. The engineering possibilities were appreciated in a measure, but as the features of the lake itself are so little known the situation was not fully understood or the extent of the project grasped. The aim of the company is to eliminate the long, expensive grades around the north end of the lake, at the same time reducing the distance and curvature, and for this purpose a competent corps of engineers was ordered into the field, or, more properly speaking, into the lake, a year ago. Several steam launches were used and a most careful reconnaissance of the famous body of water followed. This resulted in a preliminary survey from Lucin to Ogden, and upon this preliminary survey was worked up into a tangible form an excellent line between the two places. The preliminary work was attended by hardships which can only be appreciated by those who have an intimate knowledge of the lake. In April one of the launches was wrecked and the crew barely escaped.

In July the Ogden & Lucin Railroad Company was

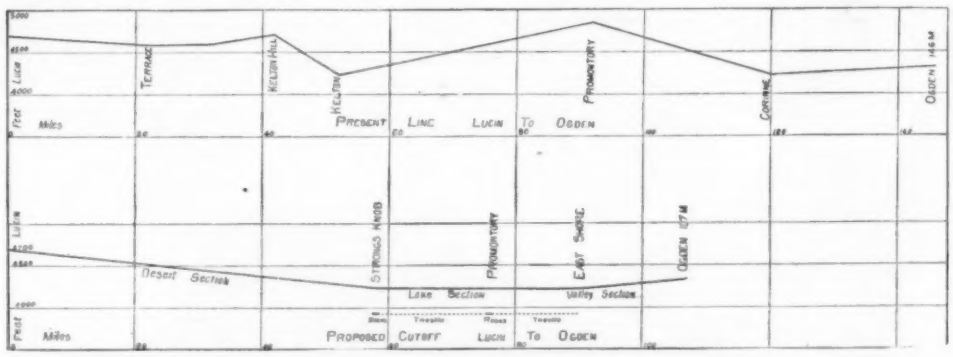


PROPOSED SALT LAKE CUT-OFF.

incorporated by Southern Pacific attorneys. The articles were filed at Salt Lake City. In the meanwhile the surveys were continued, revised and improved and the right of way at the Ogden end secured. At present the surveys are completed and in the hands of Chief Engineer Hood; the right of way has been secured and material is being unloaded at various points between Lucin and Ogden, a large number of pile drivers being included in the equipment. Some weeks ago it was intimated that the recent change in ownership of Southern Pacific stock would delay this work, but officials of the company think this will not be the case. They are rather of the opinion that the broad-minded New York purchasers who have expended millions in Wyoming to rectify the Union Pacific line will hurry, rather than delay, the completion of a line which, although expensive at first cost, will prove an economy in the end.

The distance from Ogden to Lucin over the present route is 146 miles. By the lake cut-off the distance is approximately 107 miles, a saving of 39 miles. The distance by stations on the cut-off are approximately as follows: Lucin to Strong's Knob, 58 miles, mostly over the north end of the Great American Desert; Strong's Knob to the Promontory, 20 miles, which requires a trestle; at Promontory, 2 miles of rock and earthwork; east side of the Promontory to the east shore, 10 miles; shore to Ogden, 17 miles.

These figures can only be approximated on account



THE SALT LAKE CUT-OFF—COMPARATIVE PROFILE OF OLD AND NEW LINE.

of the fact that the heavy rockwork at Strong's Knob and at the end of the Promontory may cause the surveys to be changed. The lake also is subject to rise and fall. It is to-day lower than ever before in its history, and all surveys have been made during low water. Local scientists declare that it will not rise again, as the water that feeds it is being permanently used for irrigation. Should this fact be demonstrated it might be possible for the engineers to secure a line requiring shorter trestles.

The section from Ogden to the shore requires ordinary valley grading, with a bridge over the Weber River. The trestle from the east shore to the Promontory across Bear River Bay does not present a formidable aspect, as the water for the most part is shallow and the bottom sandy.

At the Promontory heavy work will be encountered, the end of that point being of partly submerged rocks. The same formation is found at the north end of Gunnison Island and at Strong's Knob. The latter is sometimes an island, high water making Davis Strait between it and the mainland. Strong's Knob, however, is the only point on the west shore where such a cut-off could enter the lake. The west shore is a veritable rockbound coast, as the illustrations will show, and "a man unacquainted with the geography of the country," as John Sebastian used to say in his folders, would hardly believe that the engravings are true pictures of America's Dead Sea. Strange as it may seem, however, the narrow opening of the Great American Desert is at Strong's Knob. North are the Terrace Mountains and south are the Lakeside Mountains, barriers to the proposed railroad. The desert is in reality part of the bed of the former Lake Bonneville of the quaternary period, and this fact also greatly helped the engineers who, by utilizing the desert, secured an easy grade to Lucin, and with no heavy construction work in sight.

It can be seen at a glance that the grades on the cut-off will be very light from Strong's Knob to Lucin, a rise of less than 500 feet in 58 miles, and from the east shore to Ogden, a rise of about 100 feet in 17 miles with the level tangents on the lake.

Compared with the present line, the reductions in gradients will be most marked. Eastbound trains have to climb the Kelton Hill, Promontory Hill, and into Ogden. Westbound trains have to climb Promontory, Kelton and into Lucin. The eastbound ascent of Promontory is 40 miles, and the westbound ascent is 28 miles. Helpers are constantly in service, and the expense on this one hill is very great.

A maximum grade of less than 1 per cent can be secured on the cut-off, which, with the 39 miles saved in distance and the elimination of curvature, will give a result which would at once become apparent in the operating department.

The work of driving the piles and constructing the trestles in the lake will be an expensive undertaking, but that it can be accomplished there is no doubt.

Aside from the great saving to the operating department resulting from the construction of the cut-off, the Southern Pacific's passenger department would be able to advertise one of the most unique and interesting features of Western railroad scenery.

GOOD ROADS TRAIN, ILLINOIS CENTRAL RAILROAD.

FOR several weeks past the daily papers have reported the plans which have been under way for the equipment of a train of the Illinois Central Railroad with machinery for constructing sample stretches of public highway at points between New Orleans and Chicago. In two or three instances brief mention of these plans has been published as news items in the columns of The Railway and Engineering Review. These plans have now matured and the train, equipped in the manner previously reported by us, has been sent to New Orleans, arriving there on April 22. As this is an enterprise in which railway companies are more or less directly interested, and, in fact, one in which the railway company named is actively participating, some account of the details of the affair is appropriate and timely.

To begin with, there are, generally speaking, three parties behind the movement. The Illinois Central Railroad has donated the train and the transportation of the equipment and party, furnishing sleeping apartments and commissary facilities for eighteen people, besides the services of six laborers, who are with the train. Another party consists of seven manufacturers of road-making machinery, who pay for the privilege of representation on the train and supply the men to operate their own machines, with which the practical demonstrations of road-making will be made. The other party is the National Good Roads Association, under Mr. W. H. Moore, president, who has charge of the expedition. This association is represented by eleven other men, including the secretary of the association, the private secretary of the president, the official photographer of the association and the engineer of the association, who will be the foreman of all the work of road construction which will be undertaken. Accompanying the party of the National Good Roads Association are the Hon. Martin Dodge, director of the office of public road inquiries of the Agricultural Department, Washington, D. C., and Mr. Charles T. Harrison, road expert of this department. It should be understood, by the way, that the national government is co-operating with the National Good Roads Association in the movement. Four or five representatives of the large metropolitan dailies will be in continual attendance, and as guests of the Good Roads Association, Mr. A. W. Campbell, director of the road department of Ontario, Canada; and the Hon. Andrew Pattullo, Member of Parliament of the Canadian government, will be with the train.

Aside from the object lessons which will be afforded by the operations of road construction, the purpose of the movement, and really the main object, is to organize district road improvement associations at the points where the train will stop, and State associations at the State capitals, to carry the work forward from this initial movement. To this intent the train is accompanied by the road experts already named, and meetings will be held at which the problems of and the means for the improvement of the public highways will be publicly discussed. In fact, an ef-

fective organization is already in existence in each place where the train will stop. The plans for the movement have been under way for some time and local committees have been appointed to have things in readiness for the arrival of the train and the work to follow. The co-operation of the farmers and other persons in each locality visited is the strength which must be depended upon for results, and to this end the local committee in each place is required to furnish not less than ten laborers and not less than twelve teams for the service of the outfit.

The train was on exhibition at a "good roads" convention held in New Orleans on April 29 and 30. There was also a demonstration of the operation of road-making machinery by the construction of a half-mile of highway. The train left New Orleans about May 1, and will stop at several places en route north from that point, where meetings in the interest of road improvement will be held and demonstrations will be made in road construction. The roads at these points will be constructed of raw material available in the locality. That is to say, no rock will be carried for the purpose of making macadam roads, but when such material is available in the locality it will be utilized. Where rock is not available the possibilities of road-making from the natural surface material will be shown, the purpose being to teach the farmers what can be done in the way of road improvement with the materials at hand, and to encourage them in carrying the good work forward. Thus, in Louisiana, Mississippi and Tennessee, it is expected to build only dirt roads, except at New Orleans, where oyster and clam shells will be used to some extent. At some of the points in Kentucky and Illinois gravel and broken stone will be available and will be used.

Stops will be made at the following places and conventions will be held at these paces on the dates stated: Natchez, Miss.; Vicksburg, Greenville, Miss.; Clarksdale, Miss.; Oxford, Miss. (State convention); Grenada, Miss.; McComb City and Summit, Miss.; Jackson, Miss. (State convention); Jackson, Tenn.; Owensboro, Ky.; Louisville, Ky. (where the State good roads' convention will be in session); Cairo, Ill., and thence to Centralia, Effingham, Mattoon, Champaign and Kankakee, Ill.

In the equipment of the train the following manufacturing companies have taken part: The Austin & Western Company, Harvey and Aurora, Ill.; the F. C. Austin Manufacturing Company, Harvey, Ill.; the Western Wheeled Scraper Company, Aurora, Ill.; the J. I. Case Manufacturing Company, which furnishes a traction engine; Brinly Hardy, of Louisville, Ky., who furnishes large plows; the American Road Machinery Company, of Kennett Square, Pa., which furnishes a road machine; and a firm in Canton, Ohio, which furnishes road scrapers. By kindness of the F. C. Austin Manufacturing Company we have been furnished with the following detailed list of machines sent by that company:

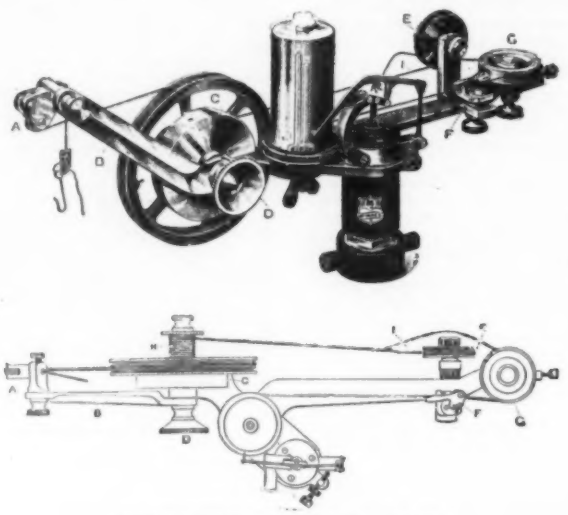
New Era road graders, for making road embankment with berms and ditches on either side, providing for drainage; harrows, for pulverizing clods thrown up by the grader; 3½-ton reversible rollers, for rolling roadbed; contractors' "fifth wheel" dump wagon and end dump wagon, for fills or macadam; tile ditcher, for giving perfect drainage to roadbed; wheel scrapers, drag scrapers, plows, etc., for general road work; jaw crusher outfit, portable, complete, consisting of Austin No. 3 jaw crusher, mounted on wheels, with elevator, screen bins and a Case traction engine, for making macadam; reversible road grader, for leveling and repairing roadbeds; stone spreading wagon, two-wheeled dump cart, for distributing macadam in repair of roads; six hundred gallon platform sprinkler with low seat; standard sweeper with rattan, hickory and wire brooms; grader with gleaner attachment, for cleaning mud from pavement; and an asphalt cleaner with can, cart brooms, etc.

The Western Wheeled Scraper Company sent a rock crusher, two new Western Aurora grading machines and a drag scraper.

It is calculated that the road graders will be adapted to sections of the country where the land is low, and where the earth alone must be depended upon for a roadbed. A road of this character can be constructed at much less cost than a macadam road, and with good results, for the reason that with the earth borrowed from the ditches which provide drainage the roadbed is built up to an elevation of 3 or 4 feet above the level of the adjacent land, and 6 to 7 feet above the bottom of the ditches at the sides, which, with harrowing and rolling during the process of construction, makes a finished roadbed ready for immediate use, and which improves rather than deteriorates by use. After a rainy season, should the roadbed be cut up, the use of a reversible grader, followed with a roller, will, at a very nominal cost, put it in good condition.

AGAR'S INDICATOR REDUCING GEAR.

THE accompanying engravings illustrate a reducing gear manufactured by T. S. M'Innes & Co., Limited, Clyde Place, Glasgow. At first sight it seems a portentous piece of mechanism to attach to an indicator, but it is made throughout of aluminium and is very light. Pulleys of different diameters are used to reduce the stroke. Below we give a plan and a perspective view of the gear. In these *A* is an adjustable pulley stud and *B* is a movable arm supporting it. These allow the cord to be carried to the crosshead at any angle. *C* is a drum containing a spring actuating the large wheel. *D* is a milled binding nut for the arm, *B*. *E* is a spring-



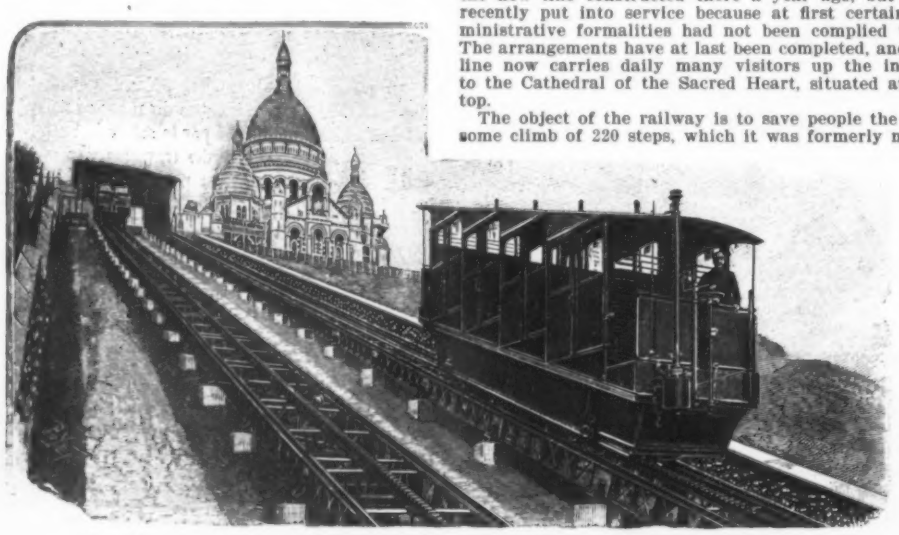
INDICATOR REDUCING GEAR.

controlled pulley, having cord, *I*, attached. This cord is tied to the main cord for the purpose of keeping the latter in tension and preventing its leaving the pulley, *H*, when the detent gear is in action. *F* is a brake or detent gear for stopping the paper barrel of the indicator without disconnecting any of the cords. *G* is an adjustable wheel round which the cord is taken from the indicator to the reducing pulley, *H*. This wheel is inclosed to prevent the cord leaving it. *H* is the reducing pulley. The diameter of this pulley depends on the length of stroke to be reduced; and *I* is the cord from the spring pulley, *E*, and attached to the cord leading to the pulley, *H*, for keeping the latter cord always tight. When unshipped from the indicator the lever, *B*, turns over so as to occupy as little space as possible. We believe that a good many of these reducing gears are in use and giving much satisfaction.—The Engineer.

THE MONTMARTRE INCLINED RAILWAY.

A NEW railway, constructed in the heart of Paris, is quite an important event, especially so when it is built for a purpose and in a manner entirely different from what we are accustomed to see. This is the case with the new line constructed there a year ago, but only recently put into service because at first certain administrative formalities had not been complied with. The arrangements have at last been completed, and the line now carries daily many visitors up the incline to the Cathedral of the Sacred Heart, situated at the top.

The object of the railway is to save people the tiresome climb of 220 steps, which it was formerly necessary to make to reach the cathedral, by carrying them up the incline in properly designed cars running on a straight inclined track, the difference in the level of the ends of which is 278 feet.



CAR DESCENDING MONTMARTRE INCLINED RAILWAY.

The principle adopted for the operation of the cars is not new, but is the same as that employed in many of the various mountain railways of Switzerland and Eastern France; and it is certain that if this line had been built elsewhere than in Paris, it would have passed unnoticed.

The cars are two in number, and run on two separate parallel tracks. They are fastened to a continuous cable which passes over a large horizontal pulley 25⅔ feet in diameter at each end of the line. The cars are operated by the force of gravity only. The car at the top is made heavier than the one at the bottom, and the difference in weight causes the former to descend and the latter to rise, since the two are connected by the cable.

Nothing could be simpler than this method. When the cars are about to start, the guard on the upper car is told the number of passengers in the lower one, and thus knows how much water to let into the reservoir of his car. The different divisions of the water level correspond to the number of passengers, and so the operator is able to gage the amount to a nicety. The water tank is quickly filled, and then to start the car the guard has only to release the brakes and let the car descend by gravity. As soon as it reaches the bottom the water is let out, and the same operation is repeated, the other car acting as the motor.

It is quite apparent, that on a railway of this kind the attention of the constructors is called especially to the brakes, for on them alone depends the successful and safe operation of the line. They regulate the starting and stopping of the cars at the termini, and also should be able to bring the cars to a sudden stop in case of accident.

The brakes provided in this instance are four in number. They are independent, and each is for a special purpose. The first, the one which is in constant use and which the guard can operate at any time, is a hand brake worked by a handle. It consists of a shaft situated under the car, parallel to the axles. At each end of the shaft are two pinions which establish a connection with the two brake handles placed one at each end of the car, thus allowing it to be controlled from either end. Near each of the two axles the shaft is threaded, and a slide working on the threaded part determines the pressure of two flexible brake shoes on drums that are fastened to the car axles.

The second brake works in the same manner and with the same apparatus, only it is automatic. A train of gears which multiplies the speed connects the car axle to a regulator, the movable parts of which engage in contact with the inside of a pulley and turn it when the speed of the car exceeds 50 feet per second. This speed is the maximum at which the cars are allowed to travel. If the guards do not keep the cars within this speed by means of the hand brakes, the automatic brakes will act and stop them.

Besides these two brakes, which act on the drums on the car axles, there is a second braking system absolutely independent of the former.

In the center of each track a rack runs the whole length of the incline. A cog wheel mounted on the car axle engages the teeth of the rack, and is rigidly attached to a brake drum which is instantly stopped in case the cable should break or give out in any way. This, therefore, forms a second automatic brake, which will act only in case the cable should give way; but in the event of any other accident of so serious a nature, it can be operated by a foot pedal. The cog-wheel teeth are sufficiently strong for a single one to hold the car, but are so arranged that two are always in contact.

Finally, almost as an excess of security, there is a fourth brake consisting of two clamps that hug the rail and keep the car from being thrown from the rails or overturned in case of sudden stoppage.

Considerable difficulty was found in laying the track properly because of the lack of stability of the ground at this point. Instead of laying the rails on ties in the ordinary manner, they were fastened to iron girders, and the latter supported by piers of masonry set as solidly as possible in the earth at distances of 11½ feet apart. This arrangement holds the track firmly in place, and in case of the settling or change of position of any of the piers, allows it to be easily brought in line again.

The two stations are 344 feet apart, and are large enough to accommodate a considerable number of passengers. This precaution was useful, especially when the line was first opened, for there was then a great rush of passengers, who were attracted by the novelty of the line and the low fare asked. It has been in successful operation for some time now, and reflects great credit upon its designer and manager, M. Schlussel.—La Nature.

WHAT IS A WAVE?

MR. VAUGHAN CORNISH, writing in the May number of Knowledge on the size of ocean waves, shows the difficulty of defining a wave. The following is a short extract from his article: "If we want to know the size of ocean waves it is evident that we must make up our minds whether we mean the size of the ridges and furrows which at the time actually constitute the surface

of the ocean, or, on the other hand, the size of the constituent undulations the superposition of which constitutes those ridges and furrows. The actual ridge or mound of water is not only the chief visible phenomenon but it is also a tangible, often a terrible, reality, which the sailor calls 'a sea.' On the other hand, the constituent undulations are what chiefly receive the attention of the theoretical man, and they have in some respects a greater individuality than the 'seas,' for they retain each their length and speed, and, sorting themselves as they travel beyond the storm area, they partition out the ocean among them, the longest and swiftest coming to the front, the slower and shorter lagging behind. . . . . In December, 1900, I crossed from Liverpool to Boston in ss. 'Ivernia,' and heavy weather was met with. . . . The average height of the waves on December 8 was less than the elevation of the lower deck, but the lower deck on the weather side was unsafe on account of the occasional big 'seas,' of which I measured one or two of 40 feet or upward. It is these larger seas which rivet the attention, and remain in the recollection of a spectator. I do not think anyone could fairly be blamed for saying that on this occasion the ship met with waves about 40 feet high, for they were not seen only once, but many times; yet, as well as I could guess, the *average* height of the waves was not more than 20 to 25 feet. I think it probable that when we hear from seamen that they have known the waves in a storm 40 feet, or it may be 50 or 60 feet in height, we must interpret the statement to mean that this is the measure, or estimate, of the average height of the greater waves of which some were encountered and a number seen during the storm, and I see no reason to quarrel with such a mode of statement. It admits, however, of an apparent discrepancy of probably 100 per cent between the values assigned to the height of ocean waves according to whether we adopt the concrete or the abstract notion of a wave."

PRACTICAL ALTRUISM IN THE SHOP.

DURING the past few years there have been so many prominent examples of successful business enterprises which have been obviously benefited by systematic efforts to improve the relations between the employer and the employed that the movement cannot fail to have been noticed by everyone, but probaby few realize its general character and wide scope. There seems to be a marked reaction from previous conditions in this respect which is fast assuming noteworthy proportions. Efforts to render employment attractive and surround workmen with an atmosphere which speaks of a regard for the personal comfort and conveniences of men are being put forth in a businesslike way in various parts of the world, and the tendency is toward a feeling of greater responsibility over the lives of those who work with their hands. It is not believed that the motives are always entirely disinterested, but whatever the motive, any observer may see in different directions a desire to build comfortable, healthful, cheerful and well-lighted shops, and put a little moral responsibility into the relations between men.

There has been a good deal of this for years in such organizations as Krupp's in Germany, in various other large foreign industries and on the French railways; the idea is not new, but it is now taking a prominent place in the policies of many enterprises. We make no comment upon the methods, comparisons of details or criticisms of various effects produced by different plans, but it is to the general principle that better work is done by comfortable, contented workmen that we wish to draw attention. Never before has such attention been given to the heating, lighting and ventilation of shops and the arrangement and equipment of toilet conveniences, and in large railroad shops these factors are now so prominent that the matter calls for examination and comment. A workman in a shop where absolutely nothing is done for his comfort does not fail to become impressed with the fact that he is there for what may be got out of him and it must have its effect upon his work. As he is supposed to be a reasonable being it is fair to expect that he will respond equally to that which will put a little of something besides the mere money-paid-for-work-done idea into the relations between the parties concerned.

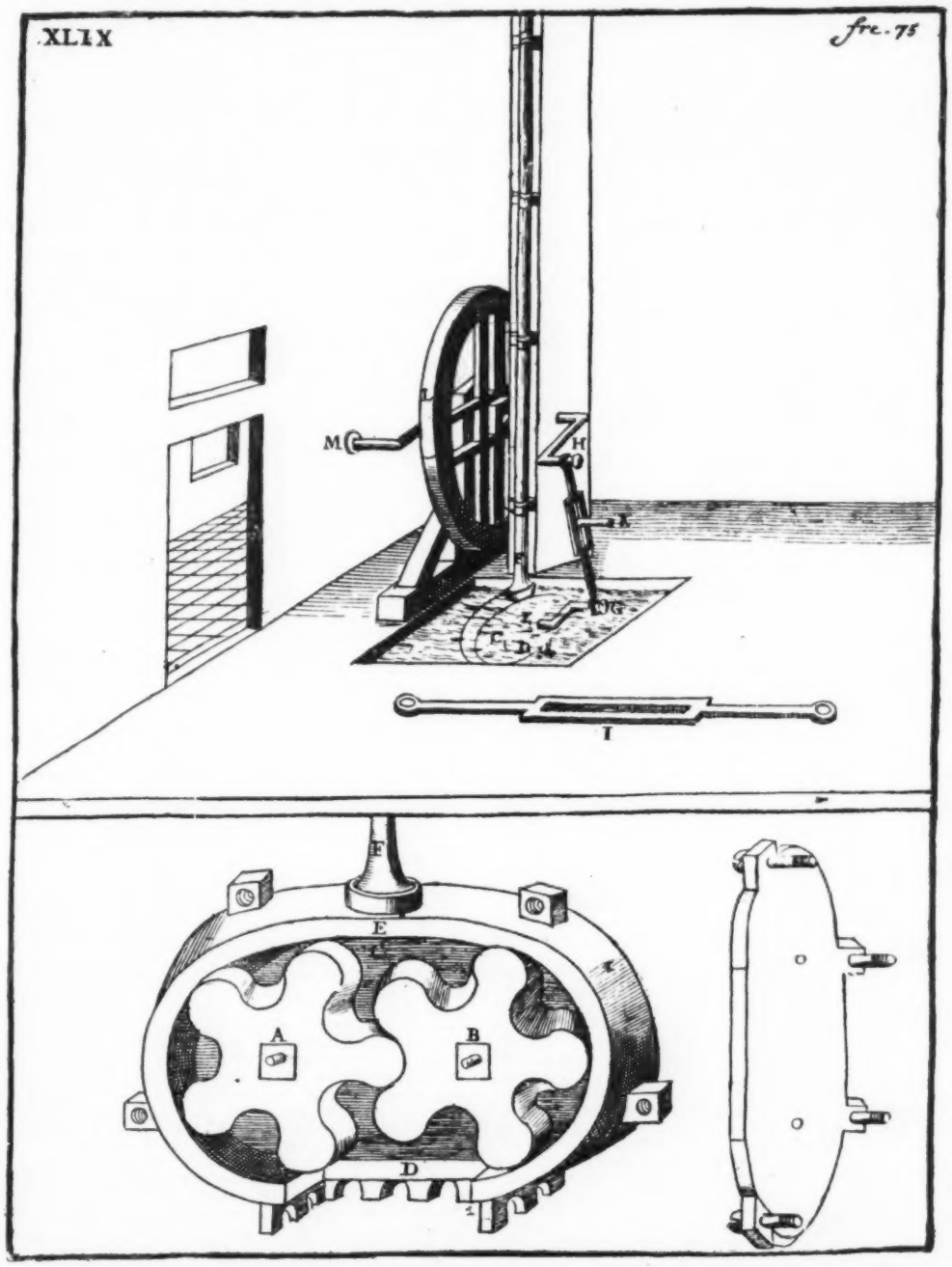
Some of the examples noted here may be considered unusual and extreme cases, and, perhaps, some may have been criticised already, yet they all stand for an established principle. The Brown & Sharpe, of Providence; Sherwin-Williams Co., Cleveland Hardware Co., Cleveland Twist Drill Co.; the T. B. Laycock Manufacturing Co., of Indianapolis; Acme White Lead Co., of Detroit; Gorham Manufacturing Co., Joliet Steel Works, Cleveland Cliffs Iron Co., Ishpeming, Mich.; the Draper Co., of Hopedale, Mass.; the National Cash Register Co., of Dayton, Ohio; the Acme Sucker Rod Co., of Toledo, and the Crane Co., of Chicago, are examples of the principle worked out in different ways, and the testimony is universally favorable to the idea. In these establishments it appears to be the rule that the grade of workmen is improving, and in some there are even "waiting lists" for ordinary unskilled labor. There must necessarily also be a corresponding improvement in the product, as well as quantity. The plans at most of these establishments include methods of supplying noonday lunches, well cooked and attractively served at nearly exact cost, the company furnishing the equipment and dining room, paying the cooks and providing time for the necessary number of waiters from the shop force.

It is easy to go too far and overdo an idea of this kind and no doubt this will be done, perhaps it has already been done in some cases, but this will be the exception which proves the rule, and a movement which is so sensible, profitable and right must continue. In railroad service it has taken the form of Y. M. C. A. privileges, reading rooms, club rooms, hospital facilities, pension systems and improved conditions of the shops themselves and their surroundings. Of the efficency and value of the railroad Y. M. C. A. the late Cornelius Vanderbilt said:

"I have for many years felt the deepest interest in this work and believe that its importance can hardly be overestimated, both to the men and the companies in whose service they are. It educates and spiritualizes; it promotes economy and thrift; it brings railroad men together with surroundings and discussions which produce the happiest results to themselves, their families and their employers."

Recent plans for new railroad shops which have come before us always indicate an increasing tendency in this direction. One of them, in addition to a good locker house with an individual clothes locker for every man in the plant and good toilet rooms, provides for a clubhouse exclusively for the employes, to be built in order to provide a suitable place for the men to spend their noon hours and other leisure moments. In another case, where the shops are in the midst of a "shop town," the railroad company has interested itself in the village itself, in the equipment of waterworks, the laying out of streets, the planting of trees and many other things which will tend to attract men there and create the desire to own their homes, to become permanent. This shop has been troubled with floating men, men without families who were not content to stay anywhere more than a short time. It may become entirely different when the town is made attractive as a place to own a home.

Each case has its own peculiar conditions. Probably little that is applicable in one place may be copied from another, but there is every reason to believe that the comfortable shop and sensible way of dealing with shop employes on a strictly practical and intelligent basis will promote the best interests of the employer and earn the largest returns. It is good business policy.—American Engineer and Railroad Journal.



VERY SIMPLE MACHINE FOR RAISING WATER FROM A WELL OR RESERVOIR TO A CONSIDERABLE HEIGHT.

VERY SIMPLE MACHINE FOR RAISING WATER FROM A WELL OR RESERVOIR TO A CONSIDERABLE HEIGHT.

THE two cog wheels, *A* and *B*, which are massive and made of wood or metal, occupy the entire space of the elliptical case, *C D*, in which nevertheless they revolve freely and are so placed that their teeth work accurately into each other. The case, *C D*, should be strongly constructed, and should be open only at the bottom, *D*, as shown in the figure, and at the point, *E*, where there is an aperture of the size of the pipe, *F*. All the other parts of the case should be well joined and well luted.

It is necessary to put this case into the well or reservoir whose water you desire to use, and to fix it firmly therein, and in such a way that it may always be covered with water. Afterward you will put upon the cog wheel, *A*, the crank, *G*, which is connected with the second crank, *H*, by the piece of iron, *I*, which is obliged to follow the motion of the latter, for the reason that the piece, *I*, is provided with a slot, as the figure shows, and can move only around the fixed pin, *K*. On account of this, the two ends always partake of the same motion in all directions. Thus, when the crank, *H*, which is the same as that of the axle of the wheel, *L*, comes to revolve, the crank, *G*, must revolve also, and consequently not only its cog wheel, *A*, but likewise the cog wheel, *B*.

When these two cog wheels revolve, the water that is between their teeth at the part of the case marked *D* remains there until it has reached the part, *C*, and has been compressed there by the continual increase of water that the space between the teeth lets in. Then the water that cannot remain in this part of the case, being thus compressed and not being able to flow out again through the space through which it entered, enters the pipe, *F*, and rises therein by degrees until it reaches the place to which you desire to lift it.

A glance at the figure shows that the large wheel, *L*, and consequently its crank, *H*, and the cog wheels, *A* and *B*, are revolved by manual power.

[One of the oldest of modern rotary steam engines, that of Murdoch, was a copy of this old pump.]

From Recueil d'Ouvrages Curieux de Mecanique et de Mathematique.

ALLOTROPIC FORMS OF SILVER.—The electroplating process with silver is subject to certain irregularities which have been to a great extent cleared up by Berthelot's discovery of the four allotropic states of silver, viz., silver modified by the action of oxygen at 550 deg., silver precipitated by copper and not heated, the same heated afterward, and crystallized silver. Whenever one of these varieties is opposed to another in an electrolytic cell containing a 10 per cent solution of silver nitrate a current is generated, amorphous sheet silver being positive with respect to the other varieties. Since the amorphous variety has the greatest heat of oxidation, its electro chemical behavior is just what one might expect. The author has not succeeded in determining the E.M.F. de-

veloped between two allotropic forms, as the current never lasts more than 5 minutes. At the end of that time the surfaces of the two electrodes are equalized by the deposition upon the cathode of the particular allotropic variety of silver of which the anode consists. It is difficult also to obtain any one of the forms in a pure state, as most of the processes tried give rise to a mixture of two or more forms.—Berthelot, Comptes Rendus, March 25, 1901.

PREVENTIVE MEDICINE.

THE CITY OF HAVANA AS A NEW FIELD FOR ITS APPLICATION.*

By DR. ERASTUS WILSON.

THE progress of medical science has ever been dependent upon our increased knowledge of the natural laws that determine a state of health or disease in a far greater degree than upon the experimental application of remedies.

The caves and gravel beds of Western Europe discover to us a human history running back through unnumbered millenniums of years, even to the quaternary geologic period, and strange, indeed, is it to say, that, notwithstanding all of our boasted human intelligence, our capacities have been so obtuse and our tendencies so strong toward an indolent sinking into fortuitous habits of mere animal existence and indulgences that the laws that make for health or disease are but just dawning upon our infant understanding.

Even now the progress already made cannot be said to be so much a conquest of our astuteness, because it is clearly the result of the irrepressible and constant appeal to us for recognition by the immutable laws that govern the universe. We are at last awakening to their urgent appeals after all these centuries of incredible indifference and the senseless sacrifice of millions of precious human lives.

Man is by instinct a gregarious animal, and from his primitive wanderings and migrations he has been progressively drawing together into urban communities.

This approximation has taught us, by practical demonstration, much about the augmentation of productive power that is gained by associated efforts.

This instinctive centripetal force, ever acting upon human society, has been enormously accentuated during the last half-century by the precipitation and crystallization, so to speak, of our accumulated intelligence into mechanical forms of labor-saving machines for utilizing the imponderable forces of nature as substitutes for animal forces employed in industrial pursuits.

This surprising fact has operated a radical and far-reaching industrial revolution that has brought the material interests of human society into direct antagonism with the conservative indolence or force of habitual inertia that is so strongly intrenched in the animal nature of humanity. The introduction of labor-saving machinery has demonstrated the superior productive power of intelligent ideas over that of brute force. It has taught us that a knowledge of nature's laws has a commercial value; that it not alone cheapens production of articles, subjects of commercial exchanges, but also greatly improves their useful qualities, multiplies enormously their quantities, and facilitates and cheapens their transportation and distribution, thus imparting greater stimulus to commercial intercourse.

The advent of manufacturing machinery led directly to the establishment of the factory system with associated capital, and these industrial corporations have, for economic reasons, naturally located in or near the centers of commercial distribution—the cities or larger towns—and to them the operatives have had to migrate. Thus our increasing insight into or knowledge in natural sciences and its application to industrial arts has greatly fortified the centripetal tendencies which are drawing human society more and more into urban agglomerations and rendering its individual members more and more dependent upon each other in universal brotherhood and correspondingly greater responsibility for our sanitary conditions.

Everywhere the urban population is rapidly increasing, while the rural is but very slowly, and in many parts is actually decreasing, because of migrations to the cities and towns. In England already 75 per cent of its people live in cities and large towns.

Paris has quintupled its population during the nineteenth century, and Lyons and Marseilles have quadrupled theirs in the same space of time.

Berlin has tripled in twenty-five years, and in Belgium and Holland the statistics of the manufacturing towns show a similar wonderful growth.

Italy exhibits to us the same phenomenon: Rome and Milan have doubled their population in the last quarter-century. Genoa and Turin show a 70 per cent increase in the same space of time.

In the United States we have witnessed the same surprising growth of cities and towns, while in many parts the rural population has remained stationary or actually receded in numbers.

Thus the cities outgrew their housing capacities and even villages expanded into large manufacturing centers without any adequate sanitary appliances corresponding to the changed conditions. Tenements were overcrowded with human life from cellar to garret, often several families residing together in a single room.

Americans have felt a just pride in the rapid growth of their cities and towns, but have erroneously attributed it to their new country and its democratic institutions. This wonderful growth is not alone in American cities. The same concentration of population within urban limits has been going on all over Europe, where modern machinery has penetrated.

If it has been very marked in some American communities, it is because the wide range in that country of popular education has greatly increased the number of its inventors of labor-saving machines, thus making their employment more general there.

The general fact is the same everywhere, and is that the inevitable progress in the development of human intelligence is taking upon itself the character of a fellow worker with nature. Its ideas, crystallizing into forms of labor-saving machines that harness the forces of nature to its uses, have brought about a complete industrial revolution that is forcing upon us radical social reforms.

We are now existing under entirely new conditions, from which we cannot turn back. Our only course is to accept the inevitable and adapt ourselves to it and cope with the new problems of urban life.

At the time when mediæval cities were founded they were established as separate and independent communities. The vast network of railroads and telegraphs which now annihilate time and space, drawing the world into closer and dependent relations, did not then exist.

Their streets were a congeries of narrow, crooked, dark and untidy passageways, exhaling foul odors and dark miasma into unventilated habitations, and their rates of morbidity and mortality were consequently enormous.

The annual death rate in London prior to the great fire of 1666 was 80 per 1,000; and this is a fair sample of other cities of that time.

That of Papal Rome, even as late as 1870, when it was surrendered to United Italy, was about 35 per 1,000, and the great sanitary inspector—*Asiatic cholera*—found Naples, in 1884, even in a worse sanitary condition.

England led the way out of these untoward complications. Fire—combustion—nature's great and universal disinfectant, took upon itself the sanitation of old London, and accomplished its work in four days, consuming four-fifths of all that city's buildings.

That method of sanitation, although in that particular case quite accidental, taught a very valuable lesson to England and the rest of the world; but, notwithstanding this fact, it was not until the year 1838 that the subject was taken up seriously by the English Parliament appointing a "royal commission" to inquire into the conditions that were responsible for the high rate of morbility and mortality among the working classes of cities.

This commission, of which Mr. Edwin Chadwick—afterward Sir Edwin Chadwick—was the secretary, established the first bureau of vital statistics as the only scientific basis for sanitary inquiry, and to these bureaus we are chiefly indebted for the pointing of the way to all our modern triumphs in sanitation.

They have taught us that the laws of health require dry and clean habitations upon dry soil, built with damp courses in the foot of the walls above their foundations, that humidity may not reach the rooms by capillary attraction; that every habitation must be thoroughly ventilated by perflation; that the atmosphere of their interior and surroundings must be free from noxious miasms, from uncleanness, or, in other words, from decaying organic matter; that they should be adequately supplied with pure, potable water, and that all domestic excreta and slop-waters should be conveyed away from their vicinity before putrefactive fermentation commences within them; also all garbage from kitchen and elsewhere should be as promptly removed.

These maxims constitute the modern sanitary code. All else is commentary.

Although practical sanitation is still far behind our knowledge of the science, yet progress has been made in its application, and the aforesaid maxims mark the ideal excellence for which we are to strive.

With this ideal as our guiding star, what are the practical sanitary works necessary and possible in order to reform the unsanitary conditions of the city of Havana, so as to approximate the modern sanitary ideal to the extent of making it a safe port for commercial relations, also for permanent immigrants and for summer tourists?

The first fact that springs up before us on such an inquiry is, that the city has no excretory organs and is consequently in similar danger as that which an individual person would be in if filled with accumulated sewage and with no outlet for relief, the water consumed dissolving it and facilitating its filtration into all the tissues of the body, as it is into all the soil of our city.

The groundwork of Havana is honeycombed by privy vaults and cesspools that have, to some extent, been connected with gutters under the surface of the streets, here called sewers, thus facilitating the widespread filtration of their putrid contents into the soil.

Consequently, sewerage works are of first and immediate necessity, together with works for the drainage of the ground and storm waters that should be executed at the same time.

Thus, our soil resting upon a clayey subsoil, is humid and always filled with dissolved or suspended and decomposing organic matter, but would, if properly drained, admit the penetration of the atmosphere which gradually would purify it by oxidation and nitrification of these impurities, after which an impermeable pavement and proper sanitary inspection would protect it from further corruption and would consequently be the next sanitary work, both in importance and sequence.

For domestic uses we have an abundant supply of spring water of good quality, but it is wasted to such an extent by leaving taps open at all hours that the pressure in the distribution pipes is so reduced that upper floors are deprived of it.

Moreover, this excessive use, without proper drainage, keeps our soil in a saturated and unhealthful state, favoring the putrefactive fermentation of the organic material in the soil which fills the atmosphere with miasms, the constant inhalation of which debilitates the nervous centers and insidiously undermines our physical vigor, thus preparing us for easy victims of epidemic disease.

Experience acquired in other cities has clearly demonstrated that the only successful remedy for this abusive waste is to apply water meters, as is done with gas distribution, and collect from each tenant for the consumption, as shown by the meter, fifty gallons per capita, which quantity European practice has shown to be doubly sufficient for all necessary domestic uses, and this quantity should be supplied by the house owner.

Water meters are rapidly becoming of universal employment, and with the happiest results.

When applied in Berlin the consumption of water fell to one-half of what it was before. In Atlanta, Ga., before applying meters to the water supply, it did not reach the upper floors. After applying them, streams from the street hydrants reached above the highest building, so as to supersede the use of its steam fire engines for the extinction of fires. If applied in Havana we would have an abundant supply for all floors for all domestic purposes.

It is my concept that proper sewerage and drainage systems and regulation of our water distribution demand our first attention, and that a proper sewerage system means one that will carry all excreta and slop-waters not only out of the house, but also out of the city limits, within twenty-four hours of their delivery to it or before putrefaction invades them.

Such systems being established and good modern pavements added to them, a long step forward in sanitation will have been taken, although serious problems will still confront us.

After drainage of ground and storm water, our heavy soil and clayey subsoil will still retain a moiety of humidity. How shall we exclude it entirely from the walls of our buildings and how secure perfect ventilation and perflation of our habitations?

Opposing these last problems stand the habits and customs of antiquity firmly intrenched in inveterate inertia, which is widespread. Also we have before us no less a problem than that of a radical reform in the plan of domestic constructions, although the new plans will always have to be more or less subject to local conditions.

These conditions in many parts of the city will not admit of cellars beneath the domiciles, and in these parts the whole surface to be covered by domestic structures should be overlaid by concrete, besides a damp course at the foot of the walls just above the ground level.

On the present ground plan of domestic construction here perflation of the habitations is in most cases impossible. The whole site is covered by the building, with exception of a short and narrow courtyard, closed front and rear, and the habitations are internal rooms, the parlor alone fronting on the street, while the rear side of the house joins back to back with those of the next street.

I have witnessed the same ground plan in the houses in Pompeii, practised two thousand years ago.

In order to secure the necessary perflation of habitations the courtyard should be transferred to the rear of the site and extend to its whole width, occupying at least 25 or 30 per cent of its surface, thus the houses on adjoining streets being on the same plan; the two yards together would practically give to both houses a space for mutual perflation equal to 50 per cent of one site, and with the doors and windows of the domicile opposite to each other, a perfect perflation would result.

This reform in the ground plan should be enforced on all structures, but the old part of the city now built solid—many houses built upon the entire lot, with little or no yard—will be very difficult to reform so as to obtain for them sanitary conditions.

The introduction into them of modern water-closets connected with modern sewers and rigid and frequent house-to-house inspections, in order to insure their being maintained in comparatively aseptic condition, will be the only recourse. Female inspectors are employed in England for house-to-house inspections of domestic premises and are likely to penetrate deeper into hidden corners of domestic households than would male inspectors. It is an absurd heresy to believe that public welfare has no right to investigate into the dark corners of domestic premises and draw the skeleton from the closets into the light of day.

Also it is a hopeful, consoling thought that prospective electric tramways may soon make beautiful and healthful building sites accessible to our citizens upon near suburban heights.

I have here presented you with the leading indications which occur to my mind with respect to the possible sanitation of Havana. But they are not complete without some consideration of the subjects *of the final disposition of the sewage, the extinction of the contagious pest-breeding swamps adjoining the city and the sanitation of the harbor.*

These subjects I have treated extensively in the public press and otherwise during the last twenty years, but in order not to extend this paper to tire your attention I shall here limit myself to a brief reference to them.

Of the first I will only say that for its collection and rapid transmission outside of the city to a common receptacle, I consider the separate system of salt-glazed sewer pipes infinitely the best and most desirable. Also, as the topography of Havana is mostly as nature left it, and on many points is little above sea level, it will be necessary to divide the city into various drainage districts, with an outfall well in the lowest point of each, in order to obtain sufficient declivities for rapid gravity collection, and in each of these an electric pump or a Shone ejector to transmit the collections to the common receptacle outside the city.

As to its final disposition, I will say that Berlin expels hers through cast iron pipes of one meter diameter to her irrigation fields, some of which are from twelve to fifteen miles distant from the city. Even if the sewage of Havana is to be cast into the sea, it should be delivered to it at least ten miles to the eastward of the city, in order that no part of it may return to pollute the shore near the city limits.

In no possible contingency is it admissible that any of it or its effluent from chemical precipitation be permitted to escape into the currentless waters of our harbor, which is already little better than a stagnant cesspool.

You are now in possession of some of my views of the sanitary problems of this city, resulting from thirty-five years of residence herein. If the indications that I have given are carried into execution we would then find ourselves in far healthier surroundings; but the general problem is still further complicated by the presence of pestilential swamps adjoining the city on its southern border and a land-locked, currentless bay into which the city has been draining its putrescent excreta for centuries.

This swamp, or morass, has been formed by the

* Read at the Third Pan-American Medical Congress, Havana, February 4, 1901.—The Sanitarian.

sedimentary deposits brought down by the River Luyano and various creeks that empty into the shallow southern side of the bay. Into one of these creeks the public slaughter houses have been dumping their blood and offal during centuries, and the flood tide that rises here about fifteen inches pushes said offal back into the soft ooze of the morass, and then leaves it exposed to the scorching sun at every ebb of the tide. Add to these conditions the well-known effects of the mixing of the fresh waters of the creeks with the salt waters of the bay within the morass, and the gravity of the situation is at once apparent.

The remedy that I have often suggested in the public press and in various pamphlets, with maps and plans, is as follows: Suppress the diversion of the slaughter house wastes into the bay and isolate the morass from it by extending a sea wall from the north side of the Atares Fort due east to the railroad station at Regla, interrupted only by the entrance of the Luyano River, to be conducted through the morass by parallel walls; also gathering into it the discharge of the other creeks, except that of Peñalver, suppressing its blood and offal.

If we now draw an imaginary line parallel to the proposed sea wall at 600 meters to the north of it we inclose between the two a part of the harbor where ships formerly anchored and, not fifty years ago, but now, is encumbered with sedimentary accumulations from two to four meters deep, that are gradually encroaching upon and filling up the harbor.

By the employment of modern hydraulic dredges, such as are used in the harbor of Liverpool and the Mississippi River, and the Delaware, used at Philadelphia, these sedimentary obstructions may be transferred from the harbor to the morass on the south side of the sea wall at a cost that would not exceed twenty cents per cubic meter, and the material dredged would be more than sufficient to raise the surface of all that part of the morass lying west of the River Luyano to the level of two meters above tide water.

The part east of the Luyano River could be drained as is done in Holland by pumping, and very valuable horticultural territory would thus be reclaimed.

There remains to be considered another part of the subject, reliable data for which have not yet been obtained by experimental research. I refer to the obtension of the very desirable desideratum of producing currents within the bay or harbor.

I published, in the month of January of the year 1886, a map or plan for a hypothetical consideration of this problem, a copy of which I here exhibit for your inspection.

It was based upon the supposition, yet to be experimentally ascertained, that the Gulf Stream runs in contact with the projecting nose of our coast just beyond the battery of Santa Clara. According to the hydrographic map of the Spanish government, the submarine bottom at that particular point of the coast is nearer to the surface, thus favoring the projection of a strong stone dike five or six hundred meters into the sea, in a northwesterly direction, to intercept that current and turn it through our bay by a canal 50 meters wide by 8 meters depth of water.

If any portion of the Gulf Stream could be thus intercepted, the continued force of the current pressing it forward would raise its level by reason of its contraction of the waters of the funnel-shaped mouth of the canal, and thus give increased impulse to the current within the channel and into the bay, where so large a volume of water would be sufficient to create some movements in the waters.

If currents within the waters of the bay and harbor of Havana may not be obtained by these means, then my own ingenuity fails to resolve this part of the problem.

ESTIMATED APPROXIMATE COST OF THE SEA WALLS FOR ISOLATING THE MORASS AND LUYANO RIVER FROM THE HARBOR.

For the dike or sea wall extending from the Atares Fort to the Fesser Railroad Wharf:

Length	2,000 meters	Cubic meters.
Height	6 "	
Thickness	1 "	
	2,000 × 6 × 1 = 12,000	

Hydraulic masonry, at $10 per meter, is $120,000.

For the double dike for the conduction of the River Luyano through the morass:

Length ..... 800 meters.	
Average height ..... 4 "	
800 × 4 × 2 = 6,400, at a cost of $8 per meter	$51,200
20 per cent for contingencies	34,240
Total	$205,440

Estimate for cost of hydraulic pumping of sedimentary accumulations from the harbor, transferring it into and filling morass:

5,000,000 cubic meters, at 20 cents	$1,000,000
Total	1,205,440

Estimates for maritime canal to create currents in harbor:

Length of canal	4,000 meters.	
Width	50 "	
Depth of water in canal ...	18 "	
Average depth of excavation	13 "	2,600,000
		400,000 for contingencies.
Total	3,000,000 c. meters.	
Of this 1,000,000 meters dolomite rock, at $2 per meter ..		$2,000,000
2,000,000 meters earth, at 50 cents per meter, equals		1,000,000
Equals		$3,000,000
80,000 cubic meters walls, at $5. equals		400,000
Filling shore from Battery de la Reina to Punta		100,000
Total		$3,500,000

The marine dike, or Malecon, would cost about $6,000,000 more.

THE BACTERIA BEDS OF MODERN SANITATION.

IT is not much more than thirty years ago since the subject of domestic sanitation began to impress the public mind. In previous decades the subject was never raised because no one thought of it. It took little, if any, place in the medical or general literature of the day. It was no one's duty to think of it; the architect who planned the houses and laid out new streets never thought of it; the artless plumber never thought of it, nor dreamt of associating his craft with disease. The sense of responsibility could not exist where no one was held responsible. While all were content to live in the paradise of fools the government rested in peace, for no answers were required to questions that were never asked. Consequently there were no laws or regulations worthy of the name, no Board of Public Health. And yet for centuries this subject was crying aloud for notice, but in the universal chaos no one understood the cry. When sickness came, and death followed, it was simply accepted in deepest reverence and awe as the will of the Almighty, and so the troubled waters of affliction rose and fell, and history went on repeating itself.

Looking back from the present changed condition of human thought, it is difficult to understand how the grandparents of to-day lived at all, except on the Darwinian theory of the survival of the fittest. Personally I can recollect using the cistern on the nursery floor of my father's house as an ocean for the sailing of boats laden with merchandise of every kind. When the sea rose—which it could always do at pleasure—the merchandise would be lost, and I can see it now in mystic shapes lying at the bottom. No one thought it worth while to interfere with this amusement; but as overflow pipes in those days were not directed into the open air, and as nothing was right, and everything was wrong, a few shipwrecks more or less could make little difference, and in all probability were the lesser of many worse evils.

In the midst of this we suffered the usual penalties of ignorance, only no one ever recognized the connection between the penalties and the ignorance, and we took our fevers and desperate periods of illness as they came. The survivors were simply sent to the country to recover; but my recollections of rural life from a sanitarian's point of view would hardly bear description. Still, strange to say, we would all come back in bounding health to get our systems "educated" (as science has it) or accustomed once more to the unhealthy conditions we had left behind. In the one case the mischief lay entirely out of doors; in the other, the concentrated essence of drain poisoning reached us from within, through cisterns and pipes in every quarter.

Throughout the town there was no system of house drainage, only pipes, or rather tubes, under the streets—composed, in all probability, of the hollow trunks of trees and meant solely to carry off rain-water. Hence each house was a law unto itself; consequently the beautiful town of New Edinburgh was little removed from the historical horrors of the Old Town as far as health was concerned. In those early days the cry of "Guardez l'eau!" could still be heard in the narrow wynds off the High Street, and I can remember hearing that cry, and being instantly dragged by my friend within a doorway when "Guardez l'eau!" rang through the air, followed by a splash from a window in one of the narrow old streets of Elgin. This notification had come down from the days of Mary Queen of Scots, and was supposed to be all-sufficient.

The reason that we managed to survive was due no doubt to the fact that the human organism can be educated to bear a certain amount of poison. Dr. Joseph Priestley, the great discoverer of oxygen, proved that birds or mice put suddenly into an unhealthy atmosphere would die at once, whereas others, if gradually accustomed to it, would live. It is on the same principle that people suffering from the bite of a mad dog are subjected to successive inoculations of a similar poison in order to "educate" the system to bear finally a virus so intense that it neutralizes the power of the original poison. Still, it is not pleasant to think of our forefathers receiving this education minus the guiding hand of science, and having to run the gauntlet of so much preventible disease with all the accompaniments of suffering. The sorrow of it is beautifully expressed by Watts in his touching picture of young Love vainly struggling to keep back the grim specter of Death, whose hand is already on the rose-covered door.

In the midst of such sanitary chaos the Prince Consort died, and all that love could do was powerless to keep back death from the palace door. This deeply lamented tragedy struck a note of alarm throughout the land, and caused the wrappings of ignorance slowly to fall away and reveal to us the truth. The physicians of the day were now fully alive to cause and effect, and began to urge the necessity of reform. For some time Sir Robert Rawlinson and other pioneers had been successful in persuading the government to establish a Board of Public Health, and through this channel Acts of Parliament had been issued, and big things were done. They were done, however, before the ground was ready, before the householder understood the nature of the edict, before the British workman understood the *raison d'être* of his work, and the results were deplorable. Without attempting to be chronological, and without dwelling further on public failures which are matters of history, we shall pass on to the private efforts that brought the National Health Society into existence. It was initiated by Mr. Ernest Hart, and consisted of Sir Robert Rawlinson, Sir Edwin Chadwick, a dozen or so of practical men, and a sprinkling of women, with Miss Lankester as secretary. The meetings took place in the small first-floor front of a miserably unsanitary house not far from the spacious and healthy quarters the society now enjoys. At these meetings it was fully recognized that the fashionable world was now alive to the dangers behind the walls and under the floors of their dwellings; but a certain apathy prevailed, for the denizens of that world knew not what to do. In order to dispel this apathy the society resolved to offer help to the helpless in a series of drawing-room lectures, and owing to the energy of two or three of the ladies and the willing services of the more practical members, these lectures proved of the greatest use.

The drawing-rooms of Mayfair now opened their elegant doors to the reception of objects such as no self-respecting drawing-room had ever seen or dreamt of before. Footmen were kept busy under the secretarial eye running to and fro with rat-riddled lead pipes and a variety of curiosities brought together to illustrate the lectures. In the midst of priceless works of art hung diagrams of an appalling nature, but no one saw the incongruity, so intense was the interest in things never seen before. The rooms were crowded, and generally graced by the presence of royalty. From these drawing-rooms news spread, and the long-tabooed subject became so popular that at length no one was ashamed to inquire into the state of the drains.

While the upper classes were thus reached, the Sanitary Institute (more recently established) was doing equally good work of a more technical kind among the engineers, architects and plumbers. Many members of the one society became members of the other, and the two have invariably worked together for the public good. The result of this co-operation is that no one dreams of taking a house now without a sanitary inspector's certificate, and no surgeon will undertake a serious operation in a house of doubtful sanitary reputation.

In looking back to this time it is interesting to observe that the awakening came simultaneously with the discovery of the living cause of most diseases. The knowledge of the nature of disease *au fond* had been withheld from us for all the countless centuries of the world's history till Pasteur in his researches in molecular physics demonstrated the vitality of ferments, *i. e.*, that all decomposition and fermentation was caused by living organisms, visible only under the microscope. From this little siding of knowledge we soon reached the main line, whence we could trace disease to its living cause, and eventually came on many junctions leading to fresh discoveries of inestimable value to mankind. We are now so accustomed to the word "bacteria," which is used in a general sense to describe these living organisms, that further explanation is unnecessary.

The result of these discoveries, as we are all aware, has been to reform first surgical, and later medical practice, and to establish laboratories for the investigation of disease in connection with hospitals in every enlightened country. But what few are aware of is the fact that the principles which have led to the antiseptic treatment of wounds are found to be equally applicable to the treatment of sewage, only reversed. Where the surgeon aims at destroying bacteria to prevent the bacteria destroying his patient, the sanitary engineer invokes the aid of the bacteria to assist him in destroying and getting rid of refuse. Hence the sewage of London is now disposed of in the end through the agency of these invisible beings, acting in the river water, and when the London County Council extend the present bacteria beds sufficiently to treat the whole of the sewage by their means, the condition of the river will be even better than it is now. In the meantime it is entirely due to the chemical researches of Mr. Dibdin in this country, and later in co-operation with others in America, that millions have been saved to the ratepayers by the recognition of the action of bacteria, and by the adoption of his bacteria beds.*

They are sometimes called filter beds, because the effluent comes out sweet and clear; but it is not through filtration the mighty change is effected, but by the co-operation of the two great classes of bacteria, the aerobies and the anaerobies of Pasteur—*i. e.*, those that live in the presence of oxygen and those whose work is carried on in the absence of oxygen. Before this new method was worked out and matured by laboratory experiments, we were doing all we could, and at an enormous cost, to kill the living organisms present in all sewage by the use of chemicals. Now everything is done to promote their welfare, for at last we have recognized in these lowliest creatures the most powerful chemists the world can command. They are ever present and always ready to do the work inoffensively with the aid of man.

In a field about a hundred yards from my country house bacteria beds have been established in the simplest way possible under my own supervision, but it is only fair to add that the model I humbly copied was established in the neighboring grounds by Dibdin himself. My first introduction to these neighboring bacteria beds came as a surprise. I had heard nothing of the project, but on returning to the country after spending the winter and spring in town I strolled into the woods one summer evening where I had often strolled before, and suddenly found my immediate surroundings entirely changed. The wild tangle of my expectation had been cleared; my footsteps, unaccustomed in these parts to civilization, began to tread unwonted gravel paths—in short, the dell of yore was transformed into beautifully laid out pleasure grounds'

Beyond on the higher ground stood formidable looking breastworks which at first I could not understand, but soon discovered to be the bacteria beds of modern sanitation. As a member of the two societies I have mentioned, I quickly realized that I had wandered unexpectedly into a vast sylvan laboratory designed by man to assist Nature in her newly appointed work. There was no monotonous thud of noisy machinery to break the silence, nothing but birds singing madrigals around, and the trickling of the stream as it came down from the beds in a series of miniature cascades. Thence it went winding about in and out of rockeries and graveled ways, among reeds, sedges, and waterplants of every kind. Finally the stream ended in an artificial lake, on which water-lilies grew and afforded shade to the goldfish casting glints of light from below. Gazing into the clear pool it was difficult to realize that this was the effluent of all the drainage coming from the mansion and home-farm beyond.

But to pursue our investigation we must proceed up the dell, along by the rustic walls confining the stream, to the bacteria beds where this wonderful chemical change is effected. These, from below or at a distance, look like breastworks, as I have said, but from above they are simply two large and somewhat shallow tanks lying side by side, with another in front, all being built of brick and cement. The first two are filled with lumps of coke, and the other in front with fine coke. On the forefront of the lateral beds there is another chamber, but this is closed and different from the others. This, in fact, is the first reception chamber, through which all the drainage has to pass. It is the home of the anaerobies, quite small and dark, but has two channels leading to the coke beds, one or other channel being opened on alternate days to allow the fluid to pass onward. Meanwhile the solid matter is retained in the reception chamber, and rapidly disintegrated and liquefied by the ceaseless action of the anaerobies, those organisms which live without

* By the adoption of this scheme, even experimentally, London was saved an expense of ten millions sterling.

air. It then passes along with the fluids to be further dealt with by the aerobies in the coke beds, whose "finishing" work is done through oxidation. The object of the two coke beds side by side is to give each bed breathing time—that is to say, each alternately has twenty-four hours off duty in order to take in fresh supplies of oxygen from the air and rain. This enables the organisms to multiply with great rapidity and to become more and more effectual as time goes on. The third coke bed, of finer material, and which is daily in use, is intended for further purification before letting forth the stream. Other materials, less expensive than coke, such as clinkers, burnt brick, or old tins, would serve the purpose equally well, the object being to present as many rough surfaces to the air as possible, and to prevent clogging.

In the end, as we have seen, the effluent may serve to adorn pleasure-grounds, or may flow into a trout stream without harm to fish or fisher. But supposing for a moment we placed airtight lids over these free and airy coke beds while full? Then, indeed, all would be changed, for it would mean death to the aerobies and life to the anaerobies, who would quickly convert everything into a seething mass of decomposition, tainting the air and destroying the fish in the pool. This is a law of nature from which there is no running away, for to these microscopic organisms is given the great work of re-establishing the equilibrium of life by giving back to it all that it has formed (Pasteur). It manifests itself everywhere, even to the end of life when the lungs have ceased to breathe—have ceased, that is, *to take in oxygen*, thus leaving our bodies a prey to the anaerobies, who complete their work in the grave.

It is interesting to know that the bacteria beds of modern sanitation can be equally efficacious whether expensively carried out or simply. The principle is the same, and if understood could be adopted in all parts of the world, in rocky places such as Gibraltar, in the bush, or with armies in the field, so long as the ground afforded a natural fall for the drainage. The plan has recently been started at Harrow School with great success, but could only be adopted at Eton, for instance, by pumping, owing to the low-lying level. It is also in use for the destruction of refuse from distilleries, the effluent of which may now pass into neighboring streams without injuring the salmon and reducing the value of the fisheries. The only refuse which so far defies Nature's process is that which comes from certain paper-mills; but perhaps in time this also may be overcome, to add one more rosebud to the ever-increasing chaplet of science.—Eliza Priestley, in the Nineteenth Century, by permission of the Leonard Scott Publication Company, New York.

INDIAN WOMEN OF TEHUANTEPEC.

THE TEHUANTEPEC RAILWAY AND ITS COMMERCIAL SIGNIFICANCE.

FOR more than a decade the great commercial countries of Europe have dreamed of some short, quick route by which the western coast of the Americas and the more distant regions of Asia could be reached. Not many years have passed since the time when the European trader or tourist bound for the Pacific coast was compelled to cover the entire distance by water, rounding Cape Horn and passing through some of the most perilous waterways known to mariners. Apart from the personal danger incurred in such long voyages, commerce suffered much. During the thirties of the past century, engineers thought to relieve these troubled conditions by the building of a railroad across the Isthmus of Panama, and of a canal.

A glance at the map shows that Mexico would profit enormously by the construction of a short road extending from the Atlantic to the Pacific coast. Coatzacoalcos and Salina Cruz, the two terminal points of the Isthmus of Tehuantepec, are separated only by a distance of 173 miles. The nature of the ground offers no difficulties worth mentioning; for the greatest elevation is but 720 feet. It is therefore not astonishing that, as early as 1841, the Mexican government granted to Don José de Garay a concession to build a national road across the Isthmus of Tehuantepec, hoping thereby to attract much of the world's commerce which had sedulously avoided Mexican ports. But the Tehuantepec railway, like the unfortunate Panama scheme, was destined to be a thorn in the side of the stockholders, as well as of the government.

Even before ground was broken, war broke out between the United States and Mexico, with the result that José de Garay receded from his contract. In 1847 a New York capitalist, P. A. Hargous, undertook to build the road. He formed a company composed of financiers; but before work was begun, dissensions broke out among the members of the newly-organized company. Again the project was abandoned. Nor did better success crown the efforts of W. H. Sidell, who received the concession in 1857. In 1870 the government authorized a certain Simon Stevens, of New York, to relieve it of its difficulty, and placed the sum of 7,500 pesos per kilometer at his disposal. But Stevens did no more than his unlucky predecessors, and threw up the scheme in sheer disgust or for lack of funds, after having laid 25 miles of track—the work of ten years of spasmodic labor.

These abortive efforts finally led the government to build the road itself. After the national Congress had appropriated the necessary funds, work was begun in 1882 where Stevens had left off. In 1893 the road was completed and opened for traffic. Some twenty-seven million pesos had been spent. Unfortunately the docking facilities of Coatzacoalcos and Salina Cruz, even up to the present, have been so inadequate that foreign merchants made no use of the line. Ever since the road was completed the government has lost money—lost to the amount of two and a half million pesos.

VIEW OF THE CITY OF TEHUANTEPEC.

It has therefore been decided to let the road for fifty years to Sir Weetman Pearson, of London.

The new contractor has pledged himself to reconstruct the harbors of Coatzacoalcos and Salina Cruz and to build the necessary wharves, so that the largest ocean-going vessels will have a safe anchorage and the best facilities for discharging cargoes. The road will be devoted only to first-class traffic, for which purpose the Mexican government has agreed to pay the sum of five million pesos. Pearson has furthermore contracted to establish ocean steamship lines which are to transport both freight and passengers, and which are to touch at all ports likely to become of commercial importance. It is hoped that by these means the entire passenger and freight traffic of the Pacific coast will gradually be diverted to the Isthmus of Tehuantepec, and that at least part of the European goods destined for China and Japan will be transported across the North American continent by way of the Mexican road. The Mexican cable company during the last two decades has opened up telegraphic communication from Galveston to Tampico, Vera Cruz and Coatzacoalcos on the Gulf of Mexico, and along the line of the railroad across the isthmus to Salina Cruz, with connections leading to Central and South America, thus telegraphically linking the isthmus with the United States and Europe.—Heinrich Lemcke, in Illustrirte Zeitung.

THE GODS OF THE FILIPINOS.

By R. I. GEARE, National Museum, Washington.

IN connection with the general interest now attaching to the history of the Philippine Islands, the following account of the mythology of the people may assist in giving an insight into their mental and spiritual condition. The facts narrated in this paper were obtained from personal conversation and from some ancient Spanish records found on the island of Porto Rico.

Upon the advent of the Spaniards to the Philippine Islands in 1521, they found the natives steeped in all the superstition and barbarity of the primitive savage, and from the writings of the old missionaries, still to be found in the archives of Spain, "they had barely more civilization than the animals in the jungles." The first of the missionaries arrived about 1555, and a few years later the Dominican monks established the celebrated province of St. Rosaire, whence they spread into China and India. In 1570 Manila obtained its first bishop, and in 1645 it possessed a Dominican university.

The ancient Filipinos had innumerable gods. They peopled both the visible and the invisible world with mysterious and spiritual beings, who continually, for weal or woe, interested themselves in the affairs of the human family. These spiritual existences inhabited everything, and consequently everything was an object of worship. On the same occasion a Filipino bowed in religious homage to the sun and moon, and spread out his hands to a painted stone. He found it necessary to offer sacrifice more frequently to the bad than to the good spirits. He had his gods of the mountain, his gods of the air, and his gods of the water. No one can glance over the mythology of these people without being deeply impressed with the fact that what St. Paul said of the Athenians is true, to a very great extent, of the Filipinos: "In all things most worshipful." And it may be said that nine-tenths of the Filipinos of the present day have changed but little.

The Tagologs believed in a Supreme Being, *Bathala Meikapal*, who dwelt in the sky, the head of the Filipino pantheon. According to Father Colin "this god was a bird called *Tegmanukin*, of yellow plumage," but Father Morga, another old Spanish authority, gives the name as *Bathala*. The author of "Sanskit in the Tagolog Language" tells us that among the Pampangos *Bathala* was the name of a bird. Father Colin also states "that the bird derived its interpretation as a divinity from the rainbow."

From this we may deduce that among the peasants of Ilocanos, as well as the Tagologs, even to the present day, a thunderbolt is represented by a pig or a white fowl, so the rainbow, which is called "*Bullalagas*," would be represented by a bird, and thus the rainbow would be regarded by the Filipinos as their Supreme God.

To verify the above, the Ilocanos of the present day consider it a sacrilege to point with the finger at the rainbow, or at images of saints, believing that the finger would be shortened as a punishment. Moreover, they pay the same devotion to these two objects as they do to the Apo, or Lord, thus making the rainbow and saints the objects of veneration, with this distinction, however, that the saints are modern, while the veneration of the rainbow has been handed down to them by tradition. The Tagologs sometimes applied the term "*Badhala*" or "*Bathala*" to the comets and other constellations, believing they foretold coming events. The Malays, ancestors of the Filipinos; their neighbors the Polynesians, the ancient Germans, Persians, Arabs and almost all primitive races thought that the rainbow was not in itself a deity, but a kind of biblical Jacob's ladder. The Filipinos, themselves, believed that those who were killed by the cayman (crocodile), by lightning or the sword, ascended to heaven in the path of the rainbow.

According to Dr. G. A. Wilkins, the word *Bhatara* signifies in Sanskrit "Lord." Many of the Malay tribes call their head or Supreme God "*Bhatara gura*," the surname of Siva, the god of the Hindus, while the Dyaks of Borneo still call their god "*Mahatara*," from *maha* (great) and *bhatara* (lord).

INDIAN WOMEN OF SALINA CRUZ.

That distinguished Philippine linguist, Dr. Prado de Taverna, writes: "It may be that *bhatalla* originated from *avatara*, the descent of a god to the earth under visible form, as the avataras of *Vishnu*. It is possible that *Bathala* is the transformation of the rainbow into the bird *Tigmanukin*." "In the Malay," adds the same author, "*Berhala*, which resembles the Tagolog form, signifies an idol to which is paid divine worship."

The word *meikapal* is now only an attribute of this deity, and signifies creator, or "one who forms an object out of clay;" which was possibly derived from Christian sources and of later origin.

The ancient authorities only mention *Bathala*. Who was Bathala? The Filipinos either did not know, or did not wish him to be known. He was the god who dwelt in the heavens, perhaps a modified Jupiter. Paterna in "The Ancient Civilization of the Philippines" asserts that "*Bathala* is one substance, all action and

CABLE STATION OF THE CENTRAL AND SOUTH AMERICA TELEGRAPH COMPANY, TWO MILES FROM SALINA CRUZ.

passion, eternal, generated a second, and the two a third; and as the three created the whole universe, all things exist in his simple unity, and his unity is the multiplicity of all things; nothing exists without him."

As given by Paterna, the commandments of the Nonos are five: "To kill no living thing, not to rob, not to commit fornication, not to lie, not to drink of any intoxicating liquor." But in this he must be mistaken, for intoxication was held by the ancient Filipinos as a privilege of the chiefs and pleasing to the gods. Murder and robbery in many cases were upheld as brave deeds, for unless a man had killed many he could not wear the *potong*, or "turban of valor." The capability of lying and deceiving was with them a sign of genius, and as to sensuality, one has but to refer to the writings of the old Spanish missionaries. Even in Paterna's own works we find a confirmation of what Father Morga wrote of the unbridled lasciviousness of the Philippine Islanders.

The Tagologs called their head god *Bathala*, the native Limasan, *Abba*, the other Visayans, *Lanon*, *Dia*, or *Sidapa;* the Vicolans, *Apo*. The tribes of the hills of Abra acknowledged a head god, but were ignorant of his name, or feared to pronounce it before Christians.

Gods of the secondary rank were collectively called *Anitos*, the proper names varying according to the different dialects. The *Anitos*, according to Father Conception, were "spirits." According to Father Colin, "particular idols preserved as heirlooms." Bishop Adurate (Taragoza, 1693) states that there were good and bad *Anitos*. Most authors agree that they were held as tutelar patrons, to whom the Filipinos appealed, failing which they were chastised by the *Anitos*, on entering the forests and mountains, or when cutting trees or plants. To them they prayed for the fertility of the fields; of them they implored aid; and they commended themselves to them before going out to fish. They invoked them in all their undertakings and dangers, according as they were *Anitos* of mountains, rivers, forests, fields, harvest, house or family gods.

Father Baranera asserts that the *Anitos* were simply household gods, but for almost every undertaking there was a different one, as with the Greeks. "Among all these," writes the ancient author, Gonzales de Mendoza, "they paid the greatest reverence to an idol they it remain behind and be lost. A crazy Ilocano, losing his *Rarkarma*, was led by the Medicine Man to the place he had been accustomed to frequent. The latter then cried out, "Intayon, Intayon," so that the *Rarkarma* might be found and return to the body from which he believed it had departed.

The Ingorotes had a similar belief, i. e., that the soul after death, before going to its destination, endeavored to attract the souls of its relatives, and great efforts were made to prevent this, or secure their return.

The *anioaas* were second souls, "spirits or ethereal bodies of some kind," that escaped from the body during life, and though invisible, followed the original body in all its movements. When a spirit left a living or dead body, it was always called *alalia*, *araria*, or *anioaas*. The *alalia* was a real specter, which on the third and ninth day after death visited the house and all the places with which it was familiar in life. The howlings of a dog indicated the presence of the *alalia*, but in order to see one, the eyes had to be rubbed with humor from the eyes of the dog.

The Ilocanos and all the mountaineers, as also the Tagologs and Visayans, believed that the souls of the dead occasionally entered the bodies of some living beings, and while there were heard speaking in their own voices. In Ilocos the very old people, especially of the mountain tribe, were thought to become possessed of the departed soul, and it was believed that when, with the shivering that accompanied the demonstration, they wrapped themselves in their *lambongs*, or glossy black veiling, they actually spoke with the voice of the departed soul. The Ilocanos thought that the *Rarkarma* of the living, the *Alalia* of the dead, and the *Anioaas* of the living and dead were distinct. In North Ilocos, the idea existed that the *anioaas*, or shadow of the departed, remained on earth, that it was capable of wounding and even causing death, of quenching fire and haunting places with which it was familiar in life; while the other soul went either to heaven or hell, or to a place of temporary abode.

At the time of the Spanish conquest the Filipinos believed in two heavens, one on earth, generally a mountain retreat inhabited by *Anitos*, the other in the sun or other heavenly bodies, where *Batala* resided with the souls of those killed by lightning, the sword or by the cayman. It was also thought that spirits

The god of rain was called "Malagia" by the Manguins of Mindoro, and "Pati" by the Ingorotes.

In the pantheon of good deities were the three brothers, *Tiguiama*, *Manarna* and *Todlay*, of the Bogolos, who represented a vague resemblance to the Trinity. The first of these was possessed of all power; the second conferred rewards and chastisements; the third was the personification of the purest love, presiding at weddings, at which time an offering of boiled rice was made to him.

The god of marriage of the Visayans was *Laboadumgug*, a rock supposed to represent a native propelling a canoe with a bamboo.

The Mandayans believed in *Mansilatan* and *Badla*, father and son; from the first was derived the *busao*, a virtue that emboldened the *baganis* or chieftains. These benefactors were invoked in time of sickness, especially in cases of headache, epilepsy and paralysis, and at times when the *Babailanes* made to these gods the curious sacrifice of defacing the idols of the evil spirits, singing "*Mansilatan* will come down from heaven, and then will *Badla* make straight the earth." The Zambales adored *Akasi*, their chief god and invoked him in their difficulties and infirmities. *Malyri*, "god of strength and power," came next, and to him the greatest honor was paid. Naturally among a savage people the god of strength would receive the greatest veneration. Worship was paid to *Manlabat*, the appeaser of strife, and to *Mangalagar*, the constant friend in danger, and those who survived the incessant tribal wars gave thanks to him.

The dwellers in Bataam also believed in *Anitos* and had their idols, as well as priestesses, called by the Tagologs "*Catalonon*." The Pangasinis adored the idol *Areagoaley*, to whom they offered oil, unguents and aromatics, and at times slaves, pigs, and oxen were sacrificed in his honor.

The evil gods were well represented in the Philippine pantheon. *Mandarangan*, the principal evil *Anito* of the Bagolos, drank human blood, and dwelt in the volcano Apo. It was thought impossible to ascend this mountain without sacrificing a human being in his honor, at the same time saying, "Eat, *Mandarangan*, and drink the blood of this man." The crater was considered the mouth of the infernal regions. In addition, the Bagolos paid homage to the evil *Anitos*, *Abak*, *Kamalay*, *Siring*, *Kalambusan*, *Tagamalig* and

A MARKET-PLACE IN TEHUANTEPEC.

called *Batala*. This reference was purely traditional, they themselves not knowing why he was greater than the others, or on what account he merited higher esteem." Antonio Lombardo, a companion of Magellan, affirms "that in the island of Cebu there existed at that time certain wooden idols, hollowed out at the back, with arms and legs extended, the feet raised, having a broad face, with the mouth open, showing four large teeth like the tusks of the wild boar." According to Father Colin, the idols were "small and rudely made of stone, wood, gold and ivory, and were called *licha* or *laranan*." The principal *Anitos* were the souls of ancestors, their names varying according to the different dialects, but having the same attributes. The Pampangos and other hill tribes called this particular Anito "*irago*," signifying "shades of the departed." These deified shades were the good spirits, invoked in time of need. The evil spirit, to whom they were obliged to sacrifice through fear, had another generic name, *Dianta*, which in Visayan, and at the present time among the Teniabianos of Mindanao, signifies, according to Father Gaspar, "contrary to god." In Ilocanos they are called *Sairo* or *Dakes*, meaning "evil spirits." Later on, the name *Anito* became general for all spirits, good, bad and indifferent, as in the Malay *kanto*, derived from *lantu* in Sanskrit, meaning "dead," now signifies "evil genius."

The unique belief of two souls existed among the Filipinos. One author says that "the Bagolos of Mindanao believed that a man possessed two souls, one of which went to heaven, the other to hell. The Visayans thought that the soul, after separation from the body, was conveyed to a place of torment by the evil spirit *Pandakisita*; but in virtue of the sacrifice made by the *Bardalanes* it ascended into Paradise without passing through the various stages. This belief is not confined to any one portion of the Archipelago, viz., that one soul remained on earth to protect or molest its relatives while the other entered paradise or hell. The Ilocanos say that there is an ethereal something called *Rarkarma* innate in man, which could be lost in the forests and gardens. The man losing his *Rarkarma* remained without reason until it was found, and he who lost his *Rarkarma* ceased to have a shadow. The Ilocanos, when leaving forest or field cried, and still do so, in full voice: "*Intayon, Intayon*," that is to say, "Let us go, let us go," to remind their *Rarkarma* lest remained on the housetops to watch over their kindred, while others believed that they abandoned this life to go to particular mountains or woods, and there to sing.

The principal *Anitos* were the souls of those who died by lightning or were victims of the cayman or sword, or women who died in child-birth.

The Ingorotes of Kiangan believed that once upon a time their supreme god, *Mananahakat*, commanded the people to kill a certain chief who had committed a crime, but after seeing the headless body relented and sent his wife, the goddess *Bugan*, to bring him into heaven, but the beheaded chief disdained the flattery as well as the presents, on account of her strange dress. She then disrobed and carried him into heaven, where in course of time his head grew again, and he was afterward regaled with wine and dancing, the Ingorotes' idea of glory. The bodies of those killed by lightning, the sword or the cayman, were buried at the foot of some great tree, in a kind of tomb, and their permission had to be asked before entering the woods or before cutting down trees or plants. The names of the *Anitos* varied according to the different dialects. Among the Tagologs they are called *nuno*, or ancestral spirits, and before entering woods their consent had to be asked, failing which the intruder was punished by having his head twisted so that his face looked backward. The *nunos* lived in mounds, which were made by the *Anay* called "*punso*," from which is derived "Matanda sa punso," or "old man of the mounds," still heard in the Philippines. The Tagologs say that this fantastic old man was of the most venerable age, and was usually seen crouching in a mound. The Visayans applied the name *Talonanon* to their rural gods. The Ilocanos even now, before commencing to cut a tree in the mountain districts, first ask permission of the *Mangmangkik* by singing: "Bari, Bari, Dika agunget pari. Ta pumukan kami, iti paba kirda Kada Kami." ("Disturb not thyself, comrade, for we but cut what we are bid.") This was done to evade the grave infirmities which the *Mangmangkik*, who dwelt in the trees, might feel disposed to inflict.

The ancient Zambales had four *Anitos*, or "rural gods," for the crops: *Aniton tava*, lord of the wood and rain; *Dumangan*, whom they petitioned for the rice to seed; *Kalaskas*, who ripened the crop; *Damolog*, who preserved it from storms when ripe.

others. The last-named was a giant, and of like nature to the Anito *Angugalo*, of the Filipinos of North Luzon. The evil *Anitos* of the Mandayans, whose idols were defaced during sickness, were *Pundangnon* and his wife *Mamlimbog*. They also recognized a dwarf *Anito*, called *Kuku*, who was common in all Filipino theogony. The Ilocanos believed in *Kaibaon*, a spirit one year old, who walked with feet reversed. He possessed an extraordinary growth of hair and lived in certain thickets, invisible to the human eye. He rarely appeared, and then only to his devotees. It was held that there were many *Kaibaons* of both sexes, the offspring of evil *Anitos* and human beings.

The *Kaibaon*, in spite of his riches, delighted in theft, and charged his human friends on no account to look for what they might have lost. If this injunction was disobeyed, he cast upon them a certain powder which produced an incurable disease. They were held in great dread by the Ilocanos, and always gave warning before throwing any warm liquid upon the ground. The *Duendos* of the Tagologs must have been in the beginning identical with the *Kaibaon*, for their attributes were identical. The *Tianak* was another class of *Anitos* among the Tagologs, whose usual form was that of a new-born child, though sometimes that of a dog, a pig, or a log of wood. Its voice was that of a child. It lurked in unfrequented places and loved to bewilder the traveler by taking the form of distant lights.

Other curious demons and hobgoblins abound in Philippine superstition, too numerous to be described in detail. Among these are the giant *Tigbalang*, who, like the bogies of our own fairy tales, could take the form of any creature, but generally appeared as a horse with human skin and porcupine bristles, and went about the earth to devour children. A wild horseman called *Tuananguan* was also hostile to children. The cannibal *Kabunian* could annihilate all creation. The Filipinos had a river (or water) god, called by the Tagologs *Sinking*, and by the Ilocanos *Litao*. According to tradition, he was a diminutive man, and dwelt at the bottom of rivers or in the branches of the bamboo trees that grew on the banks. Mention is made of a goddess *Sirena*, but it is possible the idea was introduced by the Spaniards and became confused with Philippine mythology. The Pampangos called their river god *Sereno*, changing the sex, but uniting

the attributes of both deities. *Asuang* or *Bruga* was a terrible goblin who could assume various forms and devour new-born babies. He used to leave one-half of his body from the waist downward, while the other sought his daily food; and if salt was cast on the lower part, the parts could not reunite. There were other goblins called *Katatasan* who, like vampires, could fly through the air to prey upon corpses, which they ate, while others dwelt in unoccupied houses and ruins.

There were female *Anitos*, good, bad and indifferent, notably the spotless virgin *Todilon*, spouse of *Todlay*, before referred to. There were also demonesses (the wives of demons). Two of these female Anitos, *Danuguin* and *Baingan*, were styled "Mothers of the human race."

In the mountainous regions of the islands, even in the highlands of Luzon, the northernmost and largest of the group, there are still to be found savages living in the primitive state of barbarism. These are the Negritos, a branch of the Tinguianos, who are to-day in as repulsive a state of savagery as when the Spaniards landed upon the island. A physical peculiarity of this still uncivilized tribe is the curious fact that the children are born with a dark stain on their loins. This generally spreads, and finally assimilates itself with the color of the skin, which darkens as the child grows older. Another peculiarity lies in the formation of the toes, set unusually far apart, and so formed as to lay hold of the smallest objects with ease, thus enabling them to climb like monkeys and to descend a tree or rope headforemost.

Ignorant and uncivilized as these savages are, they appear to have a vague notion of some superior being and a presentiment of the soul's immortality. Some recognize a god they call *Cabiga* and his wife, *Bujon*; others venerate a deity *Amanabog* and his wife, *Dalingay*, and also a demon *Cabunion*, from whose two sons and daughters they say the human race has sprung. They have gods innumerable; gods of the air, of the water, and in fact of everything imaginable. When sickness or death approaches, the witch or sorceress of the village is called in. An ox and a pig are killed; she places the reeking skull of the pig over her own head and works herself into a frenzy of invocation.

The spirits of the dead receive special honors, and sacrifices are made in their behalf. Parental authority is unlimited, and the children of the poor become the servants of the rich. Monogamy is said to be strictly observed, but the marriage ceremony is very primitive.

AGRICULTURE IN HAWAII.

IN a report on the agricultural resources and capabilities of Hawaii, issued by the Department of Agriculture, the establishment of a government experiment station in the islands is strongly recommended, says The New York Sun. The report embodies the results of investigations made under the authority of Congress and at the instance of Secretary Wilson by Dr. William C. Stubbs, Director of the Louisiana Agricultural Experiment Stations. In describing some of the islands Dr. Stubbs says of Kauai, the Garden Isle:

"This island is so near the temperate zone that it partakes of some of its climatic characteristics. The orange and pear trees bloom in February and the fig trees bear two crops each year, one in the spring and the other in the fall. Elsewhere in the islands these fruit trees have no definite period for blooming, but continue to bloom and fruit throughout the year, often at the same time. The temperature varies greatly, often falling in winter to 50 deg. F."

Fruit trees are not the only growths that continue to blossom in the islands. The night-blooming cereus blooms every three or four weeks throughout the summer and is grown over stone fences, to which it gives the appearance of evergreen hedges. One of these at Oahu College, 200 yards in length, contains thousands of blooms at one time.

Of the home for lepers on Molokai, on which the government has spent up to date more than $2,000,000, Dr. Stubbs says: "With the present watchful care exercised over leprosy it will be only a short time before this dread disease, introduced into the island in 1853, will be completely eradicated."

One of the natural curiosities of Hawaii is a quality of grasses of the genus *Pisonia*, the fruiting perigone of which exudes a very viscid glue that sticks tightly to any object it touches, and the woodsmen utilize it in catching birds. The *Musa textilis* from the Philippines, of which comes manila hemp, is now well distributed in the islands, and Dr. Stubbs says that the growing of this in quantities for the making of manila rope is one of the future possibilities of the islands. Bananas are already exported to this country from Hawaii, but this business, the doctor says, may be greatly increased.

Rice, the cultivation of which began in the islands in 1860, is now the second crop in size and value, sugar, of course, being first. The rice cultivation is at present wholly in the hands of Chinamen, for the reason that no one else would undertake such a task as this is under the present methods. Chinamen drive Chinese water buffaloes ahead of iron harrows through watery fields, and by hand transplant the rice plants which they set out in several inches of water.

They harvest the rice by sickle, and it is trodden out by horses and conveyed to crude mills at the seashore, which are operated by water power from artesian wells higher up in the mountain slopes. The water wheels are 10 feet in diameter and 1½ feet in width, and turn stones fashioned out of lava. The winds do the winnowing.

The industry is carried on on lands that are rented at from $40 to $50 an acre. The clean yield to the acre is from 2,000 to 3,000 pounds a year. The rice sells in Honolulu for four and a half cents a pound. Dr. Stubbs asked a head Chinaman if he could make any money under these conditions, and the Chinaman replied:

"Two crops a year; one crop pay expenses, the other for me."

"If the persistent Chinaman can, by such laborious methods," says Dr. Stubbs, "wring a profit out of rice culture, it is almost certain that with improved implements for sowing and harvesting and up-to-date mills to prepare the grain for market there would be enormous gains in extensive cultivation of this cereal on the islands."

Although peanuts grow to perfection on the islands large quantities are annually imported for eating purposes. Some of those grown there mature in five months, and two crops can be grown on the same land in a year. The oil yielded by the peanut is but little inferior to the best olive oil, and "it is recorded that salads made with this oil will keep several days longer than those made with olive oil." The peanut is as easy to raise as ordinary vegetables, and yields from twenty to sixty bushels of nuts to the acre. Dr. Stubbs says:

"Vegetable oils are largely displacing animal fats, and since the oil from this plant is used for lamp, kitchen, table and in the manufacture of soap and chocolate there are no valid reasons why an extensive industry in the growth of peanuts and manufacture into oil should not spring up on the islands in the near future."

The coffee of Hawaii is of marked flavor, and the Kona coffee, known all over the world and commanding double the price of Brazilian coffee, is said to be superior to Mocha or Old Government Java. Dr. Stubbs observes that it is therefore expedient that intelligent attention be given to its culture, that more may be grown and its reputation maintained. The cultivation of coffee has in many places given way to sugar growing.

There are about sixty sugar plantations in the islands, which in 1898-99 yielded about 300,000 tons of sugar. Dr. Stubbs says:

"The dominant crop of Hawaii is sugar. Everybody is interested in it directly or indirectly. It dwarfs and belittles every other agricultural crop grown upon soils capable of yielding sugar cane. Every attempt hitherto to establish a colony of farmers in one community has eventuated in a sugar estate. As long as the present prices of sugar are maintained it is extremely doubtful whether farming as practised in the States will ever become permanent or popular on the islands.

"Wherever diversified farming can be carried on, there, perhaps, sugar cane can be grown at a greater profit than almost any other crop; and as there are mills in almost every part of the main island which are ready and anxious to buy cane, the farmer is more than apt, on account of greater profit, to gradually gravitate to the exclusive cultivation of this crop. Few places in the island where cane can be grown at all will yield less than thirty to forty tons per acre. The present price of cane per ton is $5 to $6, thus yielding a gross income of $150 to $240 per acre. Even deducting expenses of growing and harvesting there will be left a net income per acre hardly possible to be obtained by any ordinary crop."

The hides of animals killed in the islands are shipped abroad for curing, although there is an abundance of trees there which produce tannic acid in quantities which would justify extraction. Dr. Stubbs asks in view of these facts, Why not tan hides at home?

One of the most important subjects discussed by Dr. Stubbs is that of forests and forestry, and he makes some strong and direct statements in what he has to say about it. Among other things he says:

"Originally forests covered the upland plateaus and mountain slopes of all the islands. In them were to be found the finest timbers and the best of fuel. The early trade in sandalwood began the destructive process which has been continued until to-day. Large areas formerly clothed with forest cover are bare and devoid of any kind of growth. Again, large ranches, upon which roam numbers of cattle, sheep and goats, exist above the altitudes at and below which the sugar estates are established. The animals have trampled down the undergrowth and destroyed the bushes protecting the roots and trunks of the trees which made up the superb forests. Thus exposed these trees have died and soon after death are found filled with insects which hasten their complete destruction.

"Through indiscriminate and wholesale removal of timber by man and the destructive influence of mountain cattle and fires much of the original forests covering the mountain slopes have been removed and large areas of naked, bare soils or rocks remain. For years the more thoughtful students of the islands' prosperity have inveighed against this wholesale destruction. They have shown the intimate relations of forests and rainfall. They have demonstrated how essential to every industry on the islands was an abundant water supply.

"The city of Honolulu, with a population of 40,000, through its thoughtful guardians, has demonstrated the necessity of providing against a future contingency of diminished water supply. It has reclothed at a large expense mountain slopes in its rear and has placed sentinels thereon to protect these artificial forests against marauders, roaming cattle and fire. At the same time it has constructed immense reservoirs in the mountains to catch the winter rain, to supplement, in case of necessity, the numerous artesian wells within her limits.

"How to maintain an abundance of water for all of the present and prospective wants of the islands is to-day one of the most important questions in Hawaii. It is claimed that the cool forests wring from the northeast trade winds blowing continuously over the islands much of the moisture which they contain and precipitate it as rain. It is also claimed that the thick undergrowth and brush aid in conserving this moisture, sending it downward into the artesian reservoirs within and beneath the mountains rather than permitting it to discharge precipitously down the sides and into the sea."

Dr. Stubbs quotes from a letter of Prof. A. Koebele's, the territorial entomologist, in which Prof. Koebele says:

"If we look backward fifty or sixty years we would see the two large mountains of Maui met by trees on the plains; Lanai and Molokai clothed with forests; Oahu the same, native trees in numbers down to Honolulu, four miles or more of a dense and impassable virgin forest in Nuuanu Valley, the Waianae Mountains, with a mantle of beautiful green vegetation; Kauai, the fairest of all, the Lihue plains and undisturbed forest, as all along the west on the windward side, and the forest on the leeward side coming down to the sea, in parts at least, we would see in places uniformly running streams and ever flowing springs. Doubtless such has been the condition of the islands.

"The changes have been brought on to the benefit of the very few, to the detriment of the whole island and community. To-day, especially on the leeward side of the island, the cancer spots are visible everywhere and growing continuously; the grass has disappeared, each successive rain takes away more of the soil, and during the sunny days the wind is taking the same far out to sea. With these conditions, these barren spots will grow into barren rocks, where not even the denounced Lantana (the salvation plant of the island) will grow.

"I fear to express an opinion of the state of conditions fifty years hence, yet we must trust in a body of men to form laws and regulations filling the demands of the islands. What is mostly and immediately wanted are strict laws to compel every cattle owner to fence in his or her cattle, and liberty to any one to take or shoot any animal found outside such inclosures, even paying a bonus for any such beast so destroyed.

"It is only a question of a few years until all the trees on such places disappear entirely, as may be seen by the piece of land between John McGuire's house and the lava flow north, with former forest dead. It took the cattle a very few years to accomplish this. The upper part of the ranch comprises some 12,000 acres of fertile government land, covered with valuable forest trees, among them the famous Koa. It is here where we have seen the sandalwood tree over 18 inches in diameter. Five years ago the present leaseholder had to hew a trail to see the condition of the land; to-day we find a handsome open park land, so to speak, where one can ride anywhere on horseback. I venture to say that at the expiration of the lease, twenty years hence, we will find an open pasture land, very much in want of moisture."

The sandalwood forests, which were once so abundant, were destroyed very largely between 1810 and 1825, when they were cut to export the wood to China, where it is valued for incense and other purposes.

The question of procuring labor has been one of the most pressing in Hawaii during many years, and led to the encouragement of immigration from many islands; in fact, it is said from every country. Dr. Stubbs makes a quotation, while on this subject, from Prof. W. D. Alexander, the historian and Surveyor-General of the islands, which presents the Japanese in a light not often seen in the talk about Japanese labor here.

"The consent of the Japanese government to the emigration of its subjects to Hawaii was obtained with difficulty in 1884, and in 1886 a labor convention was ratified. Since then the increase of the Japanese element in the population has been constant and rapid. It rose from 116 in 1884 to 12,360 in 1890, and 24,400 in 1896. At the close of 1899 it is estimated to be about 58,000, of whom about 26,000 are employed on sugar plantations. They have for the most part been recruited from the lowest classes in Japan. Unlike the Chinese, they show no inclination to intermarry with the Hawaiians. They may fairly be characterized as versatile, ingenious, imitative, but clannish to an extreme, fickle and vain. In regard to labor unions and strikes they can give points to other nationalities. Crimes of violence are more frequent among them than among any other race.

"The excessive preponderance of males over females in Asiatic immigration constitutes a serious menace to the morals and health of the commonwealth. In 1896 the ratio of males to females was 8 to 1 among the Chinese, nearly 5 to 1 among the Japanese, 8 to 7 among the Portuguese, and 8 to 5 among other whites, the proportion for all the inhabitants being 2 to 1.

"The decrease of the aboriginal population has still continued, from 44,088 in 1878 to 40,014 in 1884, 34,436 in 1890 and 31,019 in 1896, the rate of decrease being about 1.6 per cent a year. At the same time the part Hawaiians, the offspring of intermarriages between Hawaiian women and men of other races, have been constantly increasing, from 3,420 in 1878 to 4,218 in 1884, 6,186 in 1890 and 8,485 in 1896. All these facts point to the gradual extinction of the full-blooded Hawaiians, and the absorption of the remnant of the race by the European and Asiatic population."

As showing the absolute necessity for an experiment station, Dr. Stubbs says:

"The sugar industry dominates all other interests and constitutes the chief money crop of the islands. It is operated mainly by corporations which run large estates and cultivate sugar extensively, no attention being given to other and secondary crops. Neither the laborer nor the stock used on the plantation is maintained by the products of the estate, feed, food, etc., being imported and paid for in current values. A labor crisis, a prolonged quarantine, or a suspension of ocean traffic would work sore disaster even to those estates which have enormous capital, since at no time is there a superabundance of food, either in the pantries of the plantations or in the stores of Honolulu.

"Such estates are destructive of family ties and home comforts; single men are always preferred and objection made to the incumbrances and expenses of women and children. In the islands a strong antagonism prevails against such estates, and a demand is made that the large areas formerly owned by the Crown and now leased to the sugar corporations shall be divided and subdivided, at the expiration of lease, into homesteads for occupancy by permanent farmers.

"On the contrary, it may be stated, that there is probably no industry besides sugar that can give such enormous acre yields in money and bear the heavy cost of expensive irrigation plants, steam plows, etc. It is therefore a question of serious moment whether the present conditions will be improved by the establishment of small farmers, market gardeners, dairymen, stockbreeders, etc., over the islands. I believe that the experiment station can aid largely in paving the way and inaugurating the proper methods upon which these smaller industries must be established, in order that they may (if ever) supplant the present large estates."

THE DISTRIBUTION AND CONVERSION OF RECEIVED CURRENTS.*

By HENRY GORDON STOTT.

BEFORE proceeding to the subject proper of this paper it will be interesting to give a brief description of the apparatus and lines generating, transforming and conveying the current from Niagara Falls to the Terminal House at the city limits of Buffalo, where the overhead

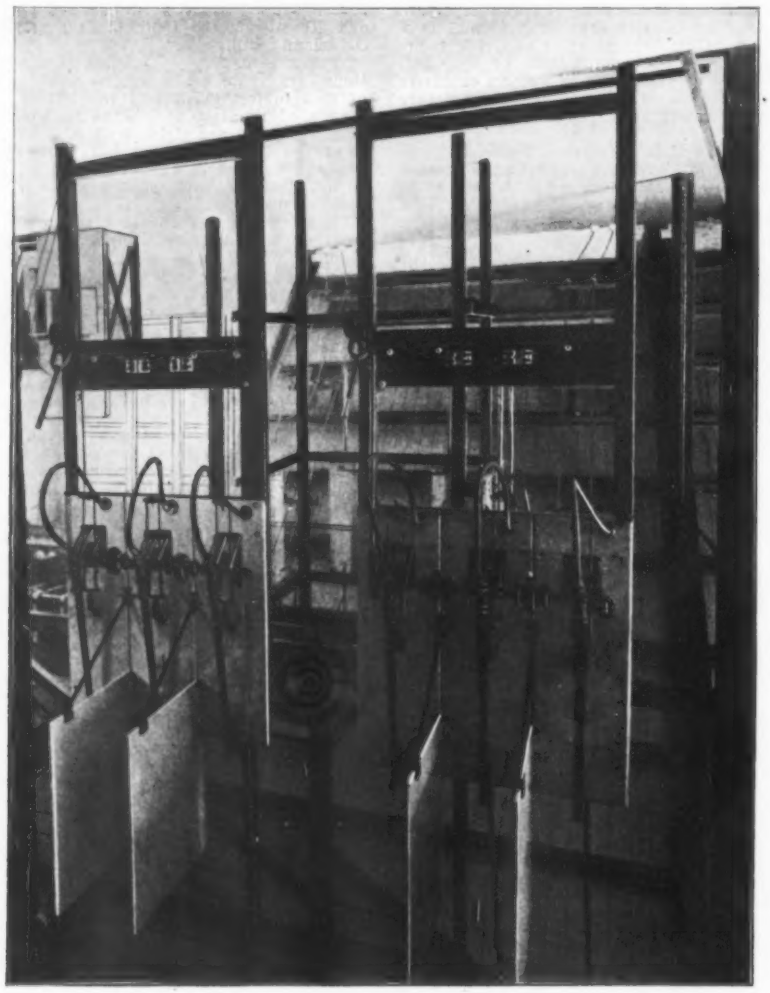


FIG. 1.

lines terminate and the underground distributing system for the various purposes to be hereafter described, begins.

The power received in Buffalo originates at the well-known plant of the Niagara Falls Power Company at Niagara Falls, N. Y., in water-driven turbines direct connected to 5,000 horse power two-phase 2,200-volt 25-cycle generators. Ten of these generators are now installed, and a new wheel pit is being excavated on the south side of the surface canal, parallel to the present power house, for twelve more generators of the same size, which will give an ultimate total capacity of 110,000 horse power, and it is a very safe prophecy to say that every horse power of it will be sold as fast as the

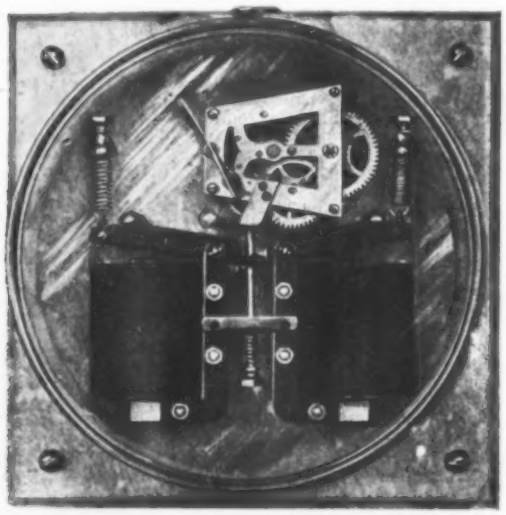


FIG. 2.—A VIEW OF ONE OF THE TIME ELEMENT RELAYS.

The two coils are connected respectively with current transformers in two phases of the line. Either releases the clockwork, which after a proper interval closes a local circuit through the tripping coils of the breakers.

turbines and generators can be installed, as the present installation of 50,000 horse power is all contracted for, and already many customers find themselves in the position of Oliver Twist, and with no better results.

The 2,200-volt two-phase current is conducted into the Transformer House, where, after passing through time element overload circuit breakers, it enters two distinct banks of step-up transformers of the air-cooled type, of an aggregate capacity of 12,000 kilowatts, which are arranged in pairs for the two three-phase connections at the same time to change the pressure to 11,000 volts. Within a couple of months the secondaries, which are now in multiple, will be connected in series to give 22,000 volts as originally intended.

The 11,000 volt three-phase current from the secondaries of the two banks of transformers is brought directly out in cables on large special porcelain insulators set in iron fixtures in the air chamber, and then on the regular helmet type porcelain insulators on timbers on the wall. The lightning arresters are of the usual multi-gap type with reactive coils in series, and in a second type with an additional check to the current in the shape of carbon resistances to prevent the live current following the lightning discharge.

The two three-phase 11,000-volt circuits running on the same pole line to Buffalo, each consist of three bare stranded copper cables of 350,000 cm. area, forming equilateral triangles on each side of the pole, the sides of the triangles being three feet. In the run of 23 miles to Buffalo, the lines are transposed five times in order to equalize and minimize the inductive drop on all phases, and at Tonawanda, where a branch line is taken off for Tonawanda and Lockport, lightning arresters are installed of a type similar to those used at Niagara Falls and Buffalo. During the first two years' operation of this line, iron guard wires grounded at every alternate pole were used for protection from lightning, but so much trouble was caused by them falling on the lines that after striking a balance between the supposed protector and the known trouble the result was so overwhelmingly against the former that the guard wires were taken down, and the interruptions due to line trouble very materially reduced. The remaining trouble on this part of the system was almost exclusively due to the ever-present boy, who speedily discovered that by a little dexterity in the manipulation of an old piece of iron wire or hoop, he could produce brilliant Fourth-of-July effects at will. The cables were, at this time, only 18 inches apart, and an arc once established would travel backward along the line with ease until the circuit breakers eventually opened at the Falls. This trouble was remedied very effectually by separating the cables three feet apart as at present, and at the same time arranging them so that they formed a triangle with the apex below instead of all being on the same plane as formerly.

At the Terminal House situated at the city limits of Buffalo, the lines now terminate in a common set of bus bars, and to these bus bars are connected the five three-conductor lead-covered cables which lead to the various sub-stations.

Simultaneously with the increase of line pressure to 22,000 volts there will be installed in the Terminal House six 2,250 kilowatts, step down transformers of the oil and water cooled type, reducing the pressure to 11,000 volts for distribution in the underground cables.

A third line is now being built from Niagara Falls to the Terminal House, following a different route, in order to give greater security of service, but as the present pole line is built with very heavy poles 90 feet apart, no great anxiety is felt as to the possibilities of even Lake Erie zephyrs combined with sleet affecting it.

Following the current as it comes in the Terminal House on the 22,000-volt lines, we first come to the lightning arresters, which are of the well-known multi-gap type, the connections to each line having a reactive coil inserted to prevent the rush of static discharge being followed by a greater current, from the line, than the gaps of non-arcing metal can interrupt by

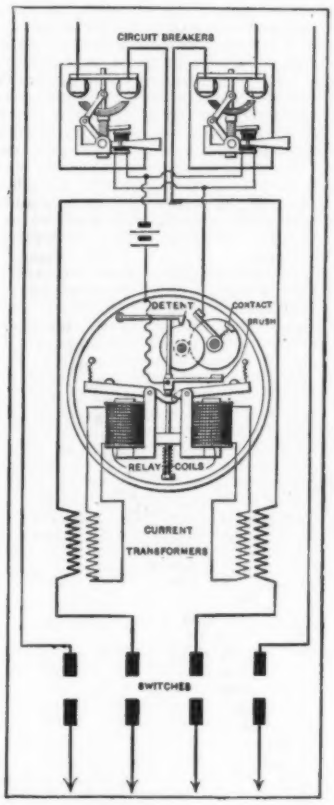


FIG. 2A.

cooling off the air and extinguishing the arc at the zero period of the wave. As an interesting fact it may be observed that the number of 1-32 inch standard gaps necessary to prevent the current arcing across under normal conditions is not directly proportional to the pressure, but increases in the same ratio as the arcing distance in air of a single gap.

The high-tension circuit-breakers, shown in Fig. 1, are of a very simple form, but one which has invariably given excellent results, being simply a long hollow wooden arm containing a flexible insulated conductor, which completes the circuit through copper contact blocks, with auxiliary carbon contacts for breaking the arc on. When the circuit-breakers open, the arm de-

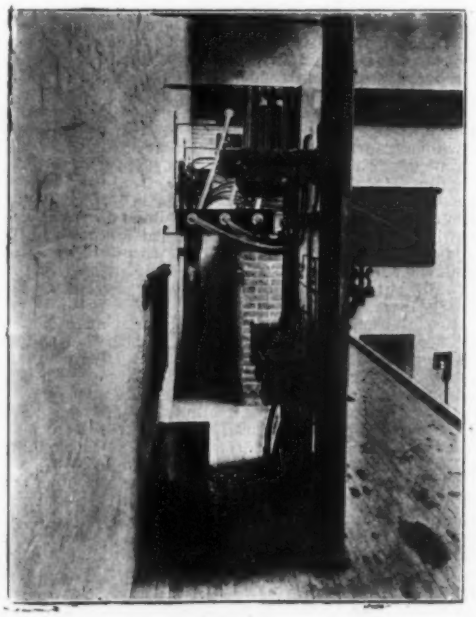


FIG. 2B.

scribes the arc of a circle giving a break of over three feet, and as the arc ascends rapidly, due to the currents of hot air generated by it, the length of the arc is rapidly increased until broken. The position of the marble barriers above the panel illustrate the height to which the arc may be expected to rise in extreme cases. After passing through the circuit breakers the current is led to bus bars, and from these to the two groups of transformers, only three cables being carried from the panels to each group of three transformers, as the

* A paper read at the 152d Meeting of the American Institute of Electrical Engineers, New York, March 22, 1901.—From the Transactions of the Institute.

delta connection is made at the terminals. The low tension, or 11,000-volt secondaries, are connected in the same way to the bus bars on the secondary panels, and from here the five three-conductor lead-covered cables distributing the current to the various sub-stations in Buffalo receive their current after passing through the usual recording and indicating meters and circuit-breakers of the same type as on the 22,000-volt side. All these circuit-breakers have a time element device which can be regulated so as to make the circuit-breakers open only after a short-circuit has lasted a predetermined number of seconds; similar

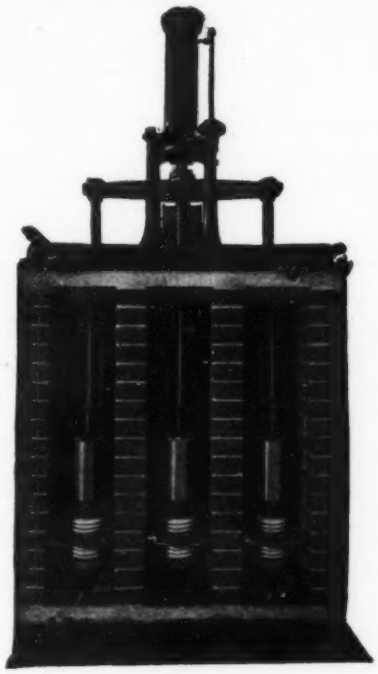


FIG. 3.

devices are used on all overload circuit-breakers, the time limit varying inversely as the distance from the source of power, in order to prevent the more distant stations shutting down the others.

We are now come to the distribution and conversion of the current in Buffalo, but the scope of this paper will only permit of the more important and novel features being taken up and described in the briefest manner possible.

DISTRIBUTION.

Referring to the diagram, Fig. 5, showing the system of distribution connecting the seven sub-stations to the Terminal House, it will be seen that there are five three-conductor cables leaving the Terminal House, each sub-station being connected to at least two cables, either one of which is capable of carrying the full load, and in the other stations having more cables, any two are capable of carrying the full load. The necessity for duplicate service to prevent shut-downs through cable trouble, is so obvious as to necessitate no further comment, but the automatic apparatus used to cut out the faulty cable is novel and interesting. Before describing the system a brief description of the various circuit-breaking apparatus used will be in order.

Fig. 1 shows a type of breaker used in the Terminal House and in sub-station No. 3, which has already been described; Figs. 2 and 2A show one known as the shunted fuse type, in which the current is carried by a spring copper leaf brush which is forced into contact with the copper blocks by means of a toggle joint lever. In shunt with this is a copper fuse wire 20 inches long of No. 22 B. & S. gage fastened in a groove in a stick having near each end brass contacts, which, when the fuse stick is forced into the receptacle mounted in the marble panel, forms a shunt on the circuit-breaker proper. The fuse stick is covered with fiber paper, and three holes are punctured through this paper, so that when the stick is in place in the inclosing wooden tube, the holes in the paper exposing the copper wire are opposite three fiber chimneys. The gases formed by the melted copper escape with such force through these chimneys, shown in Fig. 2B, that the arc formed after the circuit-breaker trips is blown out with a noise resembling the report of a pistol.

To reset the circuit-breaker, the switches in series with it are opened, the old fuse stick replaced by a new one, the circuit breaker closed, and last of all the switches. This form of circuit-breaker has given excellent results on both 2,200 volts and 11,000 volts. A time element relay is shown in Fig. 2, which is used on the overload apparatus, the retardation being accomplished by a train of clockwork operated by an ordinary spring. The brake on the clock train (which is normally at rest) is released by either of the two magnets, one being connected to the secondary of a transformer in series with phase No. 1, and the other similarly connected to phase No. 2, the diagram showing the connections for a two-phase circuit. Variation of the time limit is accomplished by changing the angle of the air paddles on an axis normal to the spindle driving them.

Fig. 3 shows a third type of switch which may be operated by air, controlled by a relay or by any other agency, and consists simply of a U-shaped copper rod connecting two brass cylinders, with spring sockets, filled with oil. When the U-shaped rods are withdrawn from the copper receptacles at the bottom of the cylinders the arc is broken in oil in two places. The cut illustrates the separation of the phases by means of brick partitions, so that in case of failure a short-circuit cannot take place. These switches have also given excellent results on all pressures.

It is quite obvious that any sub-station supplied from two cables in multiple through overload circuit-breakers, is thoroughly protected from damage due to failure of apparatus in itself, but a few moments' consideration will also show that it is not protected from a shut-down due to one of the cables supplying it becoming defective, and thereby causing the second cable's circuit-breakers to trip, from current supplied through them to the short-circuit in the cable. To obviate this the reversed current circuit-breaker has been devised, and the connections are shown in Fig. 4. The circuit-breaker proper is of the same type as those shown in Figs. 1, 2 and 3, but the novelty lies in the means of tripping it. The relay consists of a small direct current fan motor having laminated fields and armature, the armature circuit receiving current from the secondary of a transformer connected in series with one of the phases of one cable, the fields receiving current from a small constant potential transformer connected to the same phase. The armature shaft carries an arm whose play is limited between two stops, one of which is connected to the tripping coil of the circuit-breaker, the other stop being blank. Normally with these connections the torque exerted upon the armature is in such a direction that the contact arm attached to the armature shaft is strongly pulled against the blank stop, a spring assisting in this pull.

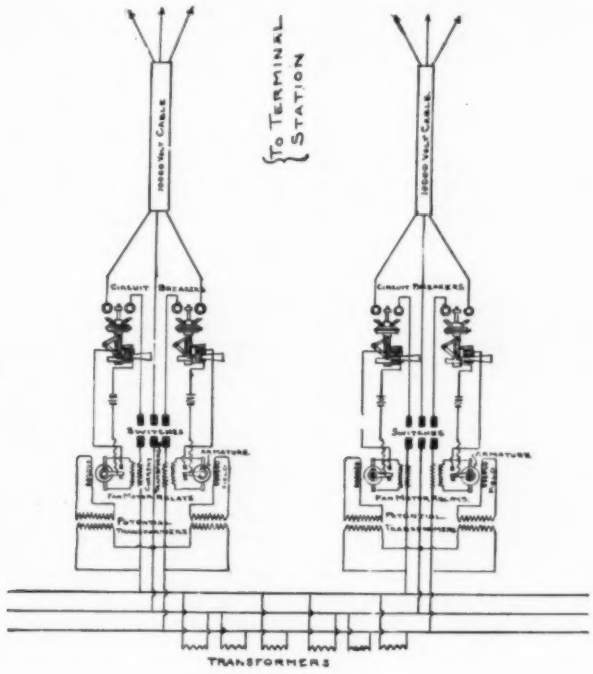


FIG. 4.

Suppose that a short-circuit comes on No. 1 cable, the conditions are now radically changed; the normal flow of current into the bus bars from both cables no longer exists, for No. 2 cable will now be feeding current into the short-circuit in No. 1 cable through the bus bars and circuit-breakers of No. 1, thereby reversing the direction of the flow of energy in the armature circuit of its relay, and as the field remains the same as before, the contact arm swings over rapidly, completing the local circuit and tripping the circuit-breakers, leaving the sub-station bus bars connected to the good cable only. The same action will take place at all the sub-stations to which this cable may be connected, and finally the overload circuit-breakers in the Terminal House will cut out the faulty cable entirely.

The five cables shown in Fig. 5, connecting the Terminal House with the sub-stations are all of the 3-conductor type, that is, have three 000 B. & S. gage copper cables separately insulated under one lead covering, the three insulated conductors being twisted into a rope, and the interstices filled with jute yarns to give an even round surface for the lead to rest on.

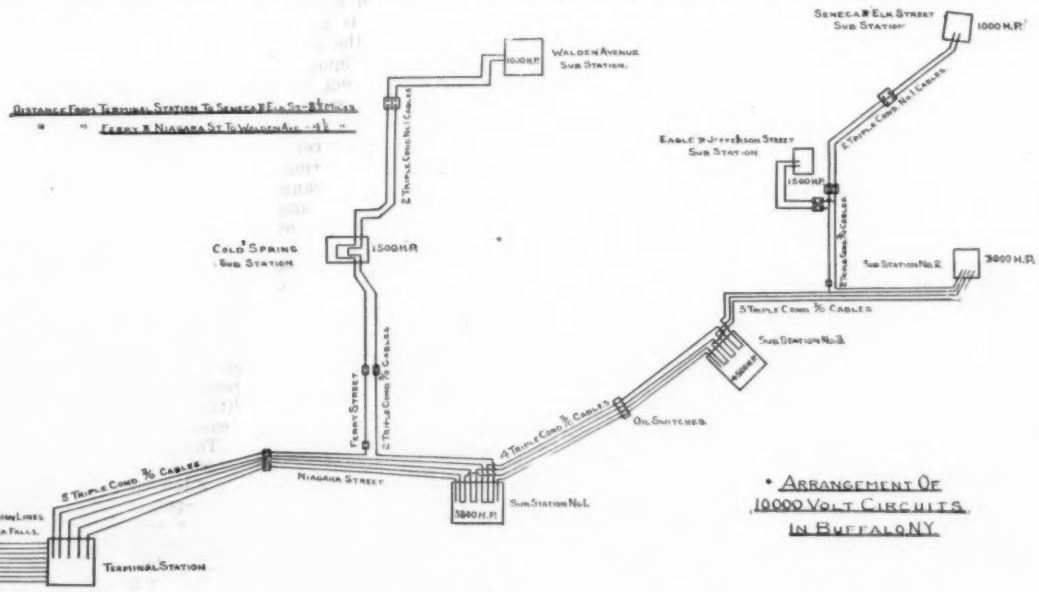

SENECA & ELK STREET SUB STATION
1000 H.P.
WALDEN AVENUE SUB STATION.
1000 H.P.
DISTANCE FROM TERMINAL STATION TO SENECA & ELK STREET SUB-STATION
FERRY & NIAGARA ST TO WALDEN AVE. - 4½ "
EAGLE & JEFFERSON STREET SUB STATION
1500 H.P.
COLD SPRING SUB STATION
1500 H.P.
SUB STATION No. 2
3000 H.P.
5 TRIPLE COND. ⅜ CABLES
SUB STATION No. 3
FERRY STREET
2 TRIPLE COND. ⅜ CABLES
4 TRIPLE COND. ⅜ CABLES
OIL SWITCHES
5 TRIPLE COND. ⅜ CABLES
NIAGARA STREET
3 TRANSMISSION LINES FROM NIAGARA FALLS.
3000 H.P.
SUB STATION No. 1
TERMINAL STATION
ARRANGEMENT OF 10000 VOLT CIRCUITS IN BUFFALO N.Y.

FIG. 5.

Three of these cables are insulated with a wall of 9-32 inch rubber mixture having 30 per cent of pure Para rubber; one has a wall of ¼-inch rubber mixture with 40 per cent pure Para, and the fifth cable has on each conductor 13-64 inch paper, and around the three insulated conductors an additional belt of 13-64 inch paper. All the cables have a lead jacket ⅛ inch thick, over all, the outside diameter of cables being approximately 2⅜ for the rubber and 2⅝ for the paper.

Experience with the first four cables seems to indicate that a rubber-insulated cable with 9.32 inch wall,

30 per cent pure Para, is perfectly reliable for 11,000 volts, but that ¼ inch insulation, even with a higher percentage of pure Para, is not.

The 18 miles of paper-insulated cable having only recently been installed, no conclusions can be drawn with safety, but as there are about 30 miles of the rubber-covered cables which have been installed for from two to three years, the above conclusions would seem to be drawn from experience with a sufficient amount of cable to justify confidence in its reliability.

In the sketch showing the cable system it will be noticed that at several points "oil switches" are indicated; these are installed in water-tight iron boxes in the manholes, in such positions as to break the cables into sections of about one mile in length, so that in the event of trouble the fault may be readily localized and the bad section switched off in the manholes without interfering with the rest of the cable.

Glazed tile conduits are used, and have proved, when dry, to be an effectual safeguard against electrolysis, the only cases of trouble from the latter having occurred in manholes in which the cables were submerged in water. Considerable trouble was caused for a time by the breaking down of the rubber near the end of the lead covering where the cables were connected to the switch-boards, and investigation showed that this was caused by the ozone generated by the static discharge taking place from rubber to lead, but this has been overcome by wiping on a large brass cable head to the lead sheath and thus greatly increasing the distance between rubber and grounded sheath, the cable head being filled with insulating compound poured in hot, a hard rubber separator keeping the rubber-covered conductors away from the brass while the compound was solidifying. Reference to the diagram, Fig. 5, will show that a further precaution has been taken at the two most important sub-stations, Nos. 1 and 3, to prevent interruption due to cable trouble, viz., to run loops from all cables into them instead of taps. By this means, if a fault should simultaneously develop in a section of one cable between these stations and in a section beyond either of them, cross-connections can be made very rapidly and easily by means of which no cable will be overloaded for more than the short period necessary to make these cross-connections.

To sum up. The means adopted for protection to the distributing system are:

1. Time element overload circuit-breakers.
2. Reversed current circuit-breakers.
3. Sectioning switches in manholes.
4. Loop switches in principal sub-stations.

(To be continued.)

THE NEW EDISON STORAGE BATTERY.*

By ARTHUR E. KENNELLY.

I TAKE pleasure in bringing to the notice of the Institute, this evening, a novel type of storage battery, recently invented by Mr. Edison.

It is well known that the history of the storage cell is essentially that of the lead cell discovered by Plante in 1860, in which lead peroxide is the depolarizing substance. An enormous amount of labor has, in the aggregate, been expended upon the improvement of this cell in the hands of experimentalists. As a result of that labor, the storage battery has at last become a recognized adjunct to direct-current central stations, but it has limitations that seem to withstand further attempts toward improvement. Of recent years, hardly any success has been met with in the direction of reducing its weight for a given energy-storage capacity, without detriment to endurance, and this weight is the great drawback of the storage battery in electric storage traction, and has been the principal obstacle to its advance in this direction for the past twenty years.

In practice, the storage energy per unit mass of the modern lead battery is from four to six watt hours per pound of battery (8.8 to 13.23 watt hours per kilogramme). Expressed in another way, a battery weighs from 124.5 to 186.5 pounds per horse power hour at its terminals (75.5 to 113.4 kilos per kilowatt hour); or, if its stored energy available at terminals were all expended in gravitational work, a battery could raise its own weight through a vertical distance of from two to three miles (3.2 to 4.8 kilometers).

While it is possible to increase the energy per unit mass by making the electrodes very light, yet this is always found to be followed by a very heavy deterioration.

Many attempts have also been made to perfect storage cells of the alkaline-zincate type, but the great difficulty of depositing zinc in coherent form from the solution, as well as the lack of a depolarizer that shall be insoluble in the electrolyte, has stood in the way of this cell's success.

Mr. Edison set himself the task of finding a cell which should possess the following advantages:

1. Absence of deterioration by work.
2. Large storage capacity per unit of mass.
3. Capability of being rapidly charged and discharged.
4. Capability of withstanding careless treatment.
5. Inexpensiveness.

He believes that the cell here shown may claim these advantages in a very satisfactory degree.

The negative pole, or positive element, corresponding to the zinc of a primary cell, or the spongy lead of a secondary cell, is iron. The positive pole, or negative element, corresponding to the carbon of a primary cell, or lead peroxide of a secondary cell, is a superoxide of nickel believed to have the formula NiO_2. The cell is therefore a nickel-iron cell, a name which suggests the structural material—nickel-steel. The electrolyte is potash; viz., an aqueous solution containing from 10 to 40 per cent by weight, but preferably 20 per cent of potassium hydroxide, the freezing temperature of which is 20 degrees below zero F., or —30 degrees C.

The initial voltage of discharge after recent charge is 1.5 volts.

The mean voltage of full discharge is approximately 1.1 volts.

The normal discharging current rate per unit area of active element (positive or negative) is 60 milliamperes per square inch; or 8.64 amperes per square foot; or 0.93 ampere per square decimeter.

The storage capacity of the cell per unit of total mass of the cell is 14 watt hours per pound; or 30.85 watt hours per kilo.

Expressing the same statement in another way, the weight of battery per unit of electric energy at terminals is 53.3 pounds per E. H. P. hour; or 32.4 kilos per kilowatt hour.

Or the battery gives energy at its terminals sufficient to lift its own weight through a vertical distance of approximately 7 miles, or 11.26 kilometers.

The mean normal discharging power-rate per unit mass of total cell is 4 watts per pound, or 8.82 watts per kilo, corresponding to a normal discharge period of 3½ hours.

The cell may, however, be discharged at a relatively high rate, in approximately 1 hour, corresponding to a discharging power-rate per unit of total cell mass of 12 watts per pound, or 26.46 watts per kilo. Charging and discharging rates are alike. That is to say, the cell may be charged at the normal rate in 3½ hours; or it may be charged at a relatively high rate in one hour, with no apparent detriment beyond a somewhat lowered electrical charge efficiency. In other words, the cell does not appear to be injured by overcharging or discharging, and only suffers in electrical efficiency under such treatment.

The positive and negative plates are mechanically alike, and can scarcely be distinguished by the eye. They differ only in the chemical contents of their pockets. The samples here exhibited, which are intended for automobile batteries, illustrate the construction. Each plate is formed of a comparatively thin sheet of steel, 0.024 inch (0.61 mm.) in thickness, out of which rectangular holes are stamped, so as to leave a grid or frame somewhat resembling a window-frame. In the plate here shown, there are three rows of eight such rectangular holes or recesses, or 24 recesses in all.

Each opening or recess is filled with a pocket or shallow box containing the active material. These boxes correspond to the panes of glass in the window-frame analogy. The panes, instead of being thinner than the frame, as in an actual window, are thicker than the frame, or project slightly beyond the surface of the steel grid. They are perforated with numerous small holes to admit the electrolyte, but entirely conceal the contained active material from view. All that meets the eye, therefore, in any of the plates, is the steel frame and its embedded "windows" of perforated steel.

The active material is made in the form of rectangular cakes or briquettes, and one such briquette is lodged in each pocket or "window pane" of the plate. Each of the plates shown, therefore, supports or contains 24 briquettes of active material, all in rigid contact with its own substance.

Each briquette is placed in a shallow, closely-fitting nickel-plated box of thin perforated crucible steel, cut from a long strip of that material 0.003 inch (0.075 mm.) thick. A cover or lid of the same material is then laid over it, so that the briquette is closely enveloped by the sides and walls of its perforated steel box. The boxes are then placed in the openings or holes in the nickel-plated steel grid, and closely fit the same. The assembled plate is then placed in a hydraulic press and subjected to a total pressure of about 100 tons. This pressure not only tightly closes the boxes, but it also forces their metal sides over the adjacent sides of the recesses in the steel grid, thus clamping the whole mass into a single solid and rigid steel plate with the hollow "window panes" full of active material. The nickel-plating of both grids and boxes aids in securing good permanent electric connections between them. The finished plate has a grid thickness of 0.024 inch (0.56 mm.), and a "window" or pocket thickness of 0.1 inch (2.5 mm.). This is the maximum thickness of the plate at any point, but, being of steel, the plate has ample rigidity.

The positive briquettes (zincs of a primary cell) are made by mixing a finely divided compound of iron obtained by a special chemical process with a nearly equal volume of thin flakes of graphite. The graphite does not enter into any of the chemical actions, but assists the conductivity of the briquettes. The graphite is divided into very thin laminæ by a chemical process, and these are passed through sieves or screens so as to leave a size or area of flake that is much larger than the area of the perforation in the steel windows. The mixture is then pressed into briquettes in a mould, under a hydraulic pressure of about two tons per square inch. The briquettes have a surface area of nearly 3 inches by ½ inch on each face.

The negative briquettes (carbons of a primary cell) are made by similarly mixing a finely divided compound of nickel, obtained by special chemical means, with a nearly equal bulk of fine flakes of graphite, and solidifying the mixture in a mould into briquettes of the same size as above.

A suitable number of positive and negative plates are assembled together, being separated from one another only by a thin sheet of perforated hard rubber.

The assembled plates are placed in a vessel or external containing cell of sheet steel containing the potash solution, which, of course, does not attack steel. There was, however much difficulty from the action of the potash on the soldered seams of the steel containing vessel. After many trials, however, Mr. Edison found a solder which seems to be entirely unaffected by the alkali.

In charging, the current is, of course, sent into the positive pole and its attached negative nickel-plate, through the electrolyte, and into the positive plate of the iron compound which carries the negative pole. This current deoxidizes or reduces the compound to spongy metallic iron and carries the oxygen through the film of electrolyte to the nickel compound, oxidizing it to the hyperoxide of nickel NiO_2, a higher oxide than the peroxide. In other words, the charging current simply carries oxygen in the opposite direction against the forces of chemical affinity, from the iron to the nickel, and stores the energy in the reduced iron, which is, of course, unaffected and passive in the presence of the potash solution. On discharge, the current passes from the positive pole through the external circuit to the negative pole, and its attached iron or positive plate, and then through the solution to the negative or superoxide. In so doing the oxygen moves back against the current and partially reduces the nickel superoxide NiO_2 while oxidizing the spongy iron. The energy of burning of the iron and oxygen which would be developed as heat in the ordinary chemical process is now liberated in the circuit as electrical energy.

The cell is an oxygen-lift. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel. The condition is then stable, until the circuit of the cell is completed. Discharge then allows the oxygen to fall back from the nickel to the iron with the natural affinity of iron and oxygen.

This action is very different from that which takes place in the lead storage cell. Here, neglecting complication, the action is usually regarded for practical purposes as being represented by the equation,

$$PbO_2 + 2H_2SO_4 + Pb = PbSO_4 + 2H_2O + PbSO_4 + 100 \text{ watt hours},$$

where the left-hand side represents the condition of charge and the right-hand side the condition of discharge. Here oxygen is not simply transferred in discharge from the peroxide to the spongy lead, but the solution is changed (theoretically) from an aqueous solution of sulphuric acid to plain water. Of course, the discharge could not practically be carried to the point of denuding the solution of all sulphuric acid, and a surplusage of acid must be used. The equation gives a mere theoretical outline of admittedly very complex reactions. In other words, the specific gravity of the sulphuric acid solution falls during the discharge, and the solution enters into the chemical combination. Theoretically, for every 445 grammes of active material on both plates, 196 grammes of sulphuric acid are required to effect the combination, or 44 per cent by weight of the active elements, and in practice it is usual to allow a weight of sulphuric acid nearly equal to half the weight of the elements, or about one-quarter of the total weight of the cell.

In the new Edison cell, on the other hand, the theoretical action of the potash solution is merely to provide the proper channel through which the oxygen ions may travel in one direction or the other—positive plate to negative plate in charge, and negative plate to positive plate in discharge. Consequently, the amount of solution needs only to be sufficient to fulfill mechanical requirements. It is believed that the weight of solution will in practice be only about 20 per cent of the plate weight, or about 14 per cent of the cell weight. In fact, the cell may be worked in the same manner as the so-called primary "dry cells." Moreover, if the solution should escape, or be carried away, by gasing in charging, the only detriment seems to be the loss of active surface thereby occasioned, and it will only be necessary to fill up the cells to the proper level with water from time to time, as evaporation or gasing may lower the level. For the same reasons the specific gravity of the electrolyte does not appreciably vary during charge and discharge.

The briquettes of active material slightly expand on receiving oxygen, and slightly contract on delivering it; that is to say, the iron briquettes contract and the nickel briquettes expand during charge, while on discharge the iron briquettes expand and the nickel briquettes contract. The level of the solution is in this way scarcely affected. The expansions and contractions of the briquettes appear to be well within the elastic limits of the spring-steel containing boxes, and consequently the electric contact is always secure. The covers or sides of the window pockets merely approach to or recede from each other slightly during charge and discharge. Fortunately, steel is the metal which possesses this mechanical elasticity in a marked degree.

The action of the charging and discharging current upon the briquettes seems to be transferred from their external surfaces inward in a manner similar to the transfer of carbon and oxygen in the process of making malleable cast iron in the furnace on the principle of cementation. No active material has been found to be ejected from the briquettes through the window perforations, even under the deliberate overcharging and discharging. Such gas as is thereby produced makes its appearance on the external surface of the windows.

If the nickel compound had no affinity for oxygen, so that energy was neither developed nor absorbed in the deoxidation or further oxidation of that substance, then the energy would be entirely that due to the energy of combination of oxygen and iron, stated to be 79.7 watt hours, and representing an E. M. F., theoretically obtainable, of 1.47 volts. If the combination of oxygen with the nickel compound be exothermic or energy-releasing, then the watt hours delivered (and the E. M. F.) will be lessened by the energy necessarily paid back to break up the combination.

If, on the other hand, the combination is endothermic or energy-absorbing, then the watt hours delivered (and the E. M. F.) will be increased by the energy restored on breaking up the combination. Since the superoxide seems not to have been known hitherto, no information concerning its energy of combination is obtainable. The electromotive force of the cell seems to be so near to that of the union of iron and oxygen as to suggest that the nickel superoxide is not far from being neutral, or that the nickel compound has but little affinity for oxygen, although the superoxide appears to be quite stable in the cell.

The new cell does not seem to be appreciably influenced by changes of temperature, and should stand a very low temperature without detriment. The electrolyte—potash—does not attack any of the ingredients of the cell, nor are any of the ingredients soluble therein. No local action occurs in the cell so far as has yet been observed, since the E. M. F. is below that necessary to decompose water.

The cell may be fully discharged to the practical zero point of E. M. F. without detriment. In fact, a cell has not only been completely discharged, but recharged, in the reverse or wrong direction, and after bringing it back to its originally charged state by proper restoration of the direction of charging current, the storage capacity remained unaffected. It would seem, therefore, that the cell should be capable of withstanding much abuse.

Mr. Edison states that "the negative plate (nickel) either charged or discharged, can be removed from a

* A paper presented at the ...th Annual Meeting of the American Institute of Electrical Engineers, New York, May 21, 1901.—From the Transactions.

working cell, and dried in the air for a week, without appreciably injuring it, and when the plate is finally replaced in the cell its charge is practically undiminished."

The positive (iron) plate, if similarly removed from the cell will be likewise uninjured, but it soon loses its charge by the oxidation of the spongy iron, with accompanying liberation of heat and appreciable rise of temperature extending over a period of several hours. On replacing the electrode, however, in the cell the storage capacity is unaffected on recharge.

As regards cost, Mr. Edison believes that after factory facilities now in course of preparation have been completed, he will be able to furnish the cells at a price per kilowatt hour not greater than the prevailing price of lead cells.

Having now considered the action and properties of the cell, a brief description may be given of the difficulties encountered in developing it.

The phenomenon of passivity has probably kept inventors from finding this cell in the past. Mr. Edison believes that of all the very numerous compounds of iron, and of which he has tried many hundreds, the particular compound which he prepares is perhaps the only one capable of being used.

If the dried hydrates or oxides of iron, native or artificial, are subjected to electrolytic reducing action in any alkaline solution, they remain inert and unaffected.

On the other hand, if finely divided iron obtained by reducing a compound of iron under the action of a reducing agent, such as hydrogen or carbonic monoxide, is subjected to electrolytic oxidation in an alkaline solution it is inert and cannot be oxidized. It assumes the well-known passive state.

The same difficulty of passivity affects the use of nickel or the negative element. Finely divided nickel, reduced from a nickel compound, remains inactive when subjected to electrolytic oxygen in an alkaline solution. The monoxide and the black-oxide or peroxide are also inert. No oxide of nickel is active or can be made active by electrolytic action, and the peroxide does not act as a depolarizer.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Production and Consumption of Copper in Germany.—The recent decline in the price of copper to £69 ($335.78) per ton in the controlling markets of England, together with the fact that the total European imports of that metal averaged only 18,091 tons per month during January, February, and March, 1901, against 23,600 tons per month from April 1 to December 31, 1900, have been widely discussed as indications of the restricted activity which now prevails in electrical and certain other branches of manufacture throughout Great Britain, France, and Germany. That this lull is but temporary and due largely to the paralysis of export trade incident to the wars in South Africa and Asia, is generally believed. Meanwhile, the slight decline in the price of copper brings that metal into closer harmony with the current values of steel and iron, and has already acted as a stimulant to consumers, who are counting on the steadily increasing production of North America to maintain the future price of copper at or even below its present value. However this may turn out, the present situation is one of unusual interest. From the German standpoint, the outlook appears to be substantially as follows:

Although complete statistics for the year 1900 are not yet at hand, it is closely estimated that out of a world's product of about 470,866 tons, North America yielded 268,787 tons; England, 520 tons; Austria-Hungary, 1,130 tons; Russia, 6,000 tons; Chile, 25,700 tons; Germany, 31,950 tons; and Japan, 27,500 tons—the remainder coming mainly from Australia, Tasmania, and Spain. According to these figures, which are expert estimates by high commercial authorities, the production of Russia declined 500 tons and that of Germany 5,726 tons as compared with those of the last preceding year.

In estimating the probable demand for copper in Germany, it will be interesting to consider the various uses to which that metal is principally applied and the present condition and outlook of the industries in which it serves as a leading material.

Besides the native supply, Germany imported last year 83,502.6 metric tons of raw copper, against 70,091.4 tons in 1899. Of this import in 1900, 66,264 tons came from the United States. Deducting from the sum of native and imported copper the 8,756 tons exported from Germany to neighboring countries, it is found that the actual German consumption of last year was about 106,696 tons, as compared with 19,622 tons in 1880 and about 48,000 tons in 1890. Of the whole amount consumed in this country last year, it is estimated that 40,000 tons were used in making electrical conductors and machinery, 20,000 tons were rolled into sheets and rods, 35,000 tons were made into brass and bronze, 3,000 tons were used in chemical manufacture, including vitriol, 20,000 tons for ship construction, boiler tubes, fire boxes, etc., and the remainder was made into coins, castings, bronze powder, builders' hardware, gas and electric light fixtures, and into various alloys with other metals.

For all these purposes except electrical manufacture, it is thought probable that the consumption of copper in Germany will not seriously decrease during the present year. How much will be used for electrical purposes is a point upon which opinions differ. Although certain branches of the industry—for instance, the construction of lighting plants—are less active than a year ago, all the great makers of generators, motors, cables, and wire are working at full time, and the extension of electric-tramway lines is active and general in England and most continental countries. A trade circular issued by Messrs. Aron, Hirsch & Son, a leading copper firm at Halberstadt, shows that during the six years from January 1, 1895, to the end of 1900, the increased consumption of copper in Germany, Great Britain, France, and North America averaged 49 per cent, while the increased world's production during the same period was only 43 per cent, and it is stated by the same authority that the total reserve stock of raw copper, instead of increasing, has diminished by 63,021 tons during the past six years.

Shipbuilding, locomotive and railway-car manufacture, telephone and electric-railway construction—all, in fact, that concerns transportation and communication—are still in general activity throughout Europe, and from all these circumstances interested experts deduce the belief that whatever may be the fate of iron and steel under the new conditions of demand and organized production, the copper market is not threatened with any immediate or serious collapse. That this judgment has caused disappointment in certain quarters is but natural. Most consumers of copper insist that the present price of that metal is artificially maintained, that it is still out of due proportion to the market values of other metals, and claim that a reduction to 14 cents per pound would not only be a saving boon to electrical manufacturing industries, but would increase by a large percentage the employment of copper for many purposes from which it is now excluded.—Frank H. Mason, Consul-General at Berlin.

Trade Opportunities in Mexico.—The following translation from a German paper is sent by Vice-Consul-General Murphy, of Frankfort, April 6, 1901:

The demand for corrugated iron is growing rapidly in Mexico, the amount imported having increased from £85,750 in 1898 to £127,750 ($417,260 to $621,632) in 1899. This article is supplied chiefly by Great Britain, the United States and Germany. Competition is sharp, and those firms secure the orders which are able to fill them most promptly and cheaply. The demand is not limited to the City of Mexico, but exists in all parts of the Republic.

There is also an active demand for—

(1) Agricultural machines and implements. These are supplied chiefly by the United States at present. In making deliveries, it is advisable to furnish duplicates of breakable parts.

(2) Machines and tools for mines. There is a good opening for the sale of these articles, although many American agencies have already been established.

(3) Pumps and other appliances for removing water from mines.

(4) Building tools, cutlery, and all sorts of iron and steel wares of good quality; also chirurgical instruments.

(5) Paints and lacquer.

(6) Glass, porcelain and faïence wares; fancy articles of leather—for example, pocketbooks, card cases, etc. These articles must, however, be finished in accordance with the demands of local taste.

German Enterprise in Central America.—The Department has received the following translation from the Berlin South American Outlook, forwarded by Vice-Consul-General Murphy, of Frankfort, under date of April 6, 1901:

German trade continues to develop rapidly in Central America. Fully $60,000,000 of German capital is invested in Central American enterprises, and German plantations occupy an area of 740,000 acres. Large German business houses in Nicaragua, Guatemala, and Costa Rica control, in addition to the entire traffic between Germany and Central America, almost the entire foreign trade of the five republics with England and California. The shipping trade along the Central American coasts is to a large extent in German hands.

Exhibit of Spanish Goods in Habana and New York.—Consul-General Lay transmits from Barcelona, April 1, 1901, translation of a cutting from the Diario de Comercio of that city, relative to a proposed exhibit of Spanish products in Habana and New York, as follows:

This exposition will consist purely of peninsular products, natural and industrial, and will have in view the furtherance of the development of Spanish trade.

It is admitted that, although all our industrial products are not able to compete with those of other countries, some can easily do so.

New York and Habana are indicated because they are well adapted to form the base of commercial transactions with Central America, Mexico, and the United States.

In Habana, this trade exposition would meet a real necessity in counteracting as far as possible the spread of American manufactures in the Cuban market, keeping up the commercial relations with Spain corresponding to her powers of production.

In New York, the main object of the exposition would be to supply the market with the enormous quantities of minerals that lie in the subsoil of Spain, thus aiding the mining industries that are being developed in the Peninsula.

Business Firms in Switzerland.—Consul Morgan writes from Aarau, April 10, 1901:

Nearly every mail which comes to this office brings letters from American manufacturers and exporters asking for names and addresses of firms doing business in Switzerland, presumably for the purpose of sending out circulars, etc. While this office is always willing to comply with the request, it often happens that the firms doing business in the particular line requested are so numerous that it is only possible to give a relatively small number of names. I would suggest that those desiring the information as above set forth should purchase the Registre du Commerce, which is published annually and contains the names and address of every business house in Switzerland, and is so arranged in one part of the volume that the different lines of business are grouped under separate headings for ready reference. The cost of the Register is $2, and it can be obtained from any bookseller in Switzerland.

New Nicaraguan Loan.—Consul Donaldson, of Managua, informs the Department that the Nicaraguan government has floated the voluntary loan of 1,000,000 pesos ($451,000*) authorized by executive decree of February 4 last. The purpose of this loan, says the consul, is to raise funds for the construction of the new Central Railway. The bonds, which were taken up by local merchants and business men, are guaranteed by 40 per cent of the customs duties collected at ports on the Atlantic coast and 10 per cent of those at ports on the Pacific coast.

Vice-Consul Scott, of San Juan del Norte, also reports the loan; he notes that 60 per cent thereof is to be in legal currency and 40 per cent in consolidated customs bonds.

* Taking the valuation of the Central American peso by the United States Treasury, April 1, 1901, at 45.1 cents.

New Electric and Water Works in Quebec.—Commercial Agent Boardman writes from Rimouski, April 6, 1901:

A company has been formed to put waterworks and an electric-light plant in Rimouski. The town has voted to guarantee the interest on $50,000 of the bonds for twenty-five years. The company has purchased good water-power and taken over the old aqueduct. Parties wishing to furnish supplies should write to Dr. G. T. Demers, secretary.

Mr. A. Portugais, an enterprising plumber of this town, wishes catalogues and price lists of plumbers' and electric supplies. He does the work for the whole county and thinks he can purchase a part of his goods, if not all, cheaper in the United States.

Canned Meats in Bond in Germany.—Mr. Jackson, secretary of embassy at Berlin, in reports dated March 18 and April 1, 1901, notes that complaints have been made that the German authorities at Hamburg would not permit the shipment in bond through Germany of sausage intended for the Austrian market. The matter having been brought to the attention of the proper officials, it was stated that this action was due to a misunderstanding. The Hamburg customs authorities have now been instructed that no objection exists to the shipment of canned meats (Büchsenfleisch) and sausage through Germany in bond, and that this rule applies to meat and sausage of American origin, even when unaccompanied by an American certificate as to sanitary conditions.

Farmers' Unions in Germany.—Consul Hughes reports from Coburg, April 12, 1901:

The farmers of the Bavarian and Wurttemberg Allgäu districts have combined for the purpose of buying all their fertilizers, both chemical and natural, at the best wholesale prices and on the most favorable conditions. They use about 1,000 wagonloads (of 200 cwt.) per year. It is also rumored that they intend to buy all their agricultural and other machines the same way. It would be well for American sellers of artificial fertilizers and for makers of American agricultural machinery to look up the persons having charge of this enterprise.

Butter Trade of Finland.—Under date of April 12, 1901, Consul Hughes, of Coburg, says that the Finland butter export trade of last year ran 115,201 kegs behind, the amount for 1900 being 10,141,538 kegs, against 10,256,739 in 1899. This is explained, first, by the partial failure of the animal-food crops, and, second, by the increased use of butter in Finland itself.

Manila Cigars in Java.—Consul Hill, of Amsterdam, April 4, 1901, says that, in view of the decline in the importation of Manila cigars into Java, from 127,600 pounds in 1894 to 12,632 pounds in 1900, the director of finances has been petitioned to abolish the preferential duty on these goods. The present tariff on Manila cigars is 80 cents a thousand, while other cigars pay only 20 cents.

Trade at Port Limon.—Minister Merry, of San José, under date of April 7, 1901, calls attention to the increase of commerce at Port Limon, and especially to the large quantity of coffee—48,105 sacks (6,124,668 pounds)—shipped to Europe via New York. English, German, Italian, and Spanish steamers, he says, call at Limon monthly, offering more direct shipment, but generally without saving of time.

Trade Openings in Brazil.—Consul Girimondi, of Santos, March 13, 1901, says that cash registers and adding machines are practically unknown in that section of Brazil and should meet with a ready sale, if properly introduced by agents speaking the language of the country. The consul also believes there is a good opening for photographic apparatus and supplies, and suggests the introduction of up-to-date postal scales to replace the crude articles in use at the present time. Even government offices, he thinks, might be persuaded to adopt a novelty in this line. Railway companies should also be approached.

Hints to Exporters to the Argentine Republic.—Consul-General Guenther, of Frankfort, March 16, 1901, states that the commercial attaché to the German consulate-general at Buenos Ayres reports that barbed wire for fences of the "estancias" and iron sheeting for roofs and walls of houses are largely imported into the Argentine Republic; the latter, suitably packed in wooden frames, often comprising the main portion of a vessel's cargo. Other articles mentioned by the attaché as finding good sales in the Argentine are remedies against the prevalent sheep itch (sarna), stoves, and preserved food.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1035. May 13.—International Labor Bureau in Switzerland—Manufacture of Celluloid in France—Caspian-Black Sea Canal—Tacoma-Liverpool Steamship Line.

No. 1036. May 14.—Spanish Exposition of Heating Appliances—Liege Trade with the United States.

No. 1037. May 15.—Cotton Growing in West Africa—Syrian Silk for the United States.

No. 1038. May 16.—Trade Outlook in Argentina—Rubber and Gutta-Percha—New German Steamship—Cement for South Africa—Electric Cars for Rapid Transit.

No. 1039. May 17.—United States Trade in Syria—Cotton in Russia.—American Coal in Japan—An Antidote to Mosquito Poison—Demand for Wire Screening in Egypt—Artificial Sulphur Water—Chinese Demand for Stearine Candles—Colombian Export Dues on Cattle—British Invention for Aerial Navigation.

No. 1040. May 18.—American Textiles for European Markets—Liverpool Medical Fellowship Open to Americans—German Customs War with Haiti—Dominican Export Duties Abolished—Steamship Concession in Liberia.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

THE EYE IN THE RECENTLY DISCOVERED CAVE SALAMANDER OF TEXAS.*

THE tailed Batrachia have during recent years attained an increased importance zoologically, by appreciation of the fact that in respect to many features in which their living representatives present a simplification of organization they are retrograde. While but one of them possesses a complete maxillo-jugal arch, none are pentadactyle in both fore and hind-limbs; and the unexpected has been reached, in the discovery that there are no fewer than ten species of six genera which are lungless, and that in some of these respiration is largely buccal or pharyngeal, and may even, in all probability, involve the tips of the toes, as in *Autodax* and species of other known genera.

Conspicuous among recently discovered species are three of American origin which are cave-dwellers. Of these, one (a *Spelerpes*), occurring in the Mississippi Vale, has nondegenerate eyes; another (*Typhlotriton*), more restricted in the same region, has eyes which during growth undergo a recognizable degeneration. The third (*Typhlomolge*), discovered in 1896 in the underground waters of Texas, where it was obtained from an artesian well, said by our authors to be now thrown up at the rate of about fifty a year, is quite blind, possessed of functionless eyes. It is with the paper upon this genus that we have chiefly here to deal. The animal itself is of especial interest, as furnishing the much-desired American counterpart for the European *Proteus* long known. It differs from this, however, in being shorter bodied and longer limbed—so much so that the limbs appear by attenuation to have become converted into tactile organs—and the discovery that the eye is destitute of lens, rods and cones, and eye-muscles (which is the most interesting fact announced in these papers) is thus intensely significant, as it presents us among the Batrachia with a condition recalling that of the famous blind locust of the New Zealand caves, in which, under the functional atrophy of the eye, the antennæ have similarly become enlongated and more important.

The second paper deals with the eye of the Mississippi cave salamander *Typhlotriton*, which, while "detecting its food by the sense of touch," shows only the first stages of that degeneration of the eye and its associated organs occurring in the Typhlomolge type. Both papers are illustrated, though very poorly, and they do not in this respect compare with previously published works on other blind animals which might be cited. Moreover, there is in the first paper an inexplicable error, for the senior author, stating that "the eye of Typhlotriton will be dealt with in another place" (i. e., the second paper herein quoted), continues erroneously to use this generic name in describing the Typhlomolge eye.

Typhlomolge is in every respect a most remarkable creature, as an examination of the example preserved in the National Museum at South Kensington will show. The description of its eye, coming to us at a time when there has just been found (in the French Congo area) a frog in which the terminal phalanges of four of the hinder digits, perforating the overlying integument as do the ribs of the long-known Pleurodile Newt, project, freely and exposed, as sharply recurved claws. All this brings forcibly before us the lesson that in morphologically specialized forms of life, such as we are too apt to pooh-pooh, there are to be found facts which, on the whole, are among the most trustworthy, in enabling us to gauge the limits of nature's operations. Truly has Weismann remarked (as pointed out by the senior author in his 1899 Woods' Holl Lecture on "The Blind Fishes") that "an investigation into the history of degenerate forms often teaches us more of the causes of change in organic nature than can be learned by the study of the progressive ones."—Nature.

AQUATIC BEETLES.

MR. G. H. CARPENTER discusses marine beetles in the May number of Knowledge. In the course of his article he says: "It is likely that in the number of kinds that occur, beetles outnumber all other insects, except possibly the flies, by the seashore, as they seem to do in the world at large. The general form of a beetle is known even to those who have never studied in detail the structure of insects. The most characteristic feature is the modification of the forewings into firm plates of leathery or horny texture, to serve as shields—'wing-cases' or elytra—for the membranous hindwings—alone used in flight—which can be folded beneath them. Beetles thus form an easily recognized order of insects—the 'Sheath-wings' or Coleoptera. And the folding up and putting away of the wings beneath their horny sheaths, as practised habitually by beetles generally, is suggestive of the fact that many beetles have entirely lost the power of flight. As a group the beetles have largely forsaken an aerial for a terrestrial life. Their armor-like coats, and the frequently flattened form in very many of the families, correspond with a life on the ground beneath stones, and in such concealed lurking places. Consequently adaptation to tidal conditions is less difficult to beetles than to typically aerial insects, and hence the large number of marine representatives of the order. . . . There are many interesting steps in the progress toward a truly marine life that can be studied among the beetles. In the great family of the Leaf-beetles (Chrysomelidæ), there is a genus (Donacia) whose species, found on freshwater plants, spend most of their time entirely submerged. Their grubs live at the bottom of the water, feeding on the roots of aquatic plants, and they are provided with two spines on the eighth abdominal segment, by means of which they pierce the roots and breathe from the air-spaces inclosed therein."

Dust Spots.—For old spots, which have dried more or less, use a little alcohol with yolk of egg. Permit the liquid to dry and then scratch off the dust. The remainder of the yolk of the egg is removed by washing with warm water, for which purpose a cloth is used.

* "The Eyes of the Blind Vertebrates of North America," by C. H. Eigenmann (Trans. Americ. Microsc. Soc., vol. xxi. pp. 49-60), by C. H. Eigenmann and W. A. Denny (Biological Bulletin, Boston, U. S. A., vol. ii. pp 33-40).

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